EXAMINED
DEP. AGR.
9 - MAR. 1917
ENTOM.

University of Maine.

Maine Agricultural Experiment Station

ORONO

BULLETIN 253 JULY, 1916

SYRPHIDAE OF MAINE

ISSUED
OCT 14 1916

This bulletin contains a general discussion of a group of flies which are, for the most part, not injurious, but beneficial in destroying crop-pests. Their life-stages, habits, structure and economic importance are described, and practical measures for increasing their usefulness are suggested.

A detailed summary is given on pages 193 to 197.

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BULLETIN 253

SYRPHIDAE* OF MAINE.**

C. L. METCALF.†

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*Pronounced Surf'-i-dee.

**Papers from the Maine Agricultural Experiment Station: Entomology 87.

†Member of the Station summer staff.

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Introduction.*

Entomologists are realizing more clearly every year the tremendous importance to agriculture and human economy of the groups of insects having the predaceous or the parasitic habit. There has long been a strong suspicion that without these natural enemies of insects man would be helpless in combating destructive crop-pests. The recent great destructiveness of certain insects introduced from foreign countries, followed by the successful repression of these pests in certain instances with their natural insect enemies (likewise introduced from foreign lands), has emphatically confirmed this opinion.

There seems to be not the slightest doubt that predaceous and parasitic insects are man's greatest ally in keeping destructive insects in control. They work without the necessity of any attention on the part of man and for the most part so unobtrusively, that most of us are unaware of their existence. It is only when some combination of conditions checks their numbers that we experience for a year or two a serious outbreak of the pests which these beneficial insects have been holding in submission and which would otherwise be seriously destructive every year.

It therefore seems desirable that we learn as much as possible about the life-histories, habits and biological relationships of such of these insects as occur in our own country. Not only because of the scientific interest which such facts may have, or so that we may learn to appreciate their value, but also in the hope that we may be able to conserve these natural resources, and possibly artificially foster, encourage, increase and transport, or extend the distribution of, the most useful ones.

One of the most universally distributed and destructive of insect groups is the Homopterous family Aphididae, or as they are commonly called, plant-lice or aphids. This group owes

*The numbers in parentheses in the text refer to papers in the bibliography, which are serially numbered.

its success not to the hardiness or resistance of the individuals but to their remarkable fecundity, for the individual aphid is conspicuously frail, defenseless and exposed throughout its life.

Because of this frailty aphids are attacked by large numbers of predators and parasites. The best known of the groups of aphid enemies are: (1) the parasitic Hymenoptera; (2) the Ladybird Beetles or Coccinellidae; (3) the Lace-winged Flies, Aphis-lions or Chrysopidae; and (4) the Flower-flies or Syrphidae. The parasitic Hymenoptera complete their transformations from eggs to minute wasps inside the body of a single aphid. The latter three groups are predaceous and grow, not at the expense of a single aphid, but by catching and eating dozens or hundreds of them. The Coccinellidae have achieved a good deal of popular interest so that there is hardly a school boy but knows that the Lady-birds eat plant-lice and are the farmers' friends. The Syrphidae, on the other hand, seem to be little known and much misunderstood by the farmer. This deplorable lack of a better popular knowledge of this group is a little hard to explain. Perhaps the principal reason is that they have been so little discussed in entomological and popular literature; and the lack of a good common name may have had its influence. Although it gives little or no intimation of the economic importance of the group, and may even be misinterpreted as indicating a habit injurious to flowers, the name "Flower-flies" seems to be the most satisfactory of the names in use; because it is based on the most characteristic habit which is uniformly true for the adults of the family: *viz,* that of visiting flowers for the purpose of getting food.

As contrasted with the Lady-birds, the movements of the Syrphid larvæ are slow, their colors subdued and their general appearance quite inconspicuous,—even repulsive. Their elongate flattened bodies are often nearly or quite covered from view by the aphids or their secretions. They are consequently usually overlooked or ignored; or the adults persecuted as "sweat-bees," under the wholly erroneous idea that they can sting; or, worse still, the flies may be accused of being responsible for the presence of the lice on the plants, or the larvæ for the damage resulting from the plant-lice.

In spite of their lack of popular recognition, I have become convinced during several years' study of this group, that, in the sections observed, the Flower-flies are a more important enemy of aphids than are the Lady-bird Beetles, and that probably they are the most important of the natural enemies of aphids. I have been gratified to find this opinion confirmed by Dr. Edith M. Patch after many years' extensive observations of the aphids of Maine.

The present bulletin deals with only one of the groups of insect enemies of aphids,—the Syrphidae. Its aim has been to elucidate the life-economy of these little-understood Flower-flies, so that the agriculturist may come to look upon them as his friends and give them his well deserved protection. And that as a basis for fostering and increasing their numbers we may have an intimate knowledge of their structure, habits and transformations. And since the larval habits are very diverse, not all being enemies of aphids and a few quite injurious, it has been deemed important to study all the species of whatever larval habit so that we may learn to distinguish the injurious and the beneficial ones.

What Flower-Flies Are.

The family Syrphidae is one of a number of families comprising the great order of insects known as the Diptera, or two-winged flies, (characterized especially by the possession of a pair of knobbed threads, *halteres,* on the thorax in lieu of the second pair of wings) and to the sub-order Cyclorrhapha, section Aschiza.

They are medium to large flies, sometimes uniformly black but usually very brightly-colored; being characteristically striped, spotted or banded with bright yellow on a blue, black or metallic ground-color. The yellow occurs especially commonly as transverse bands or fasciae on the abdomen, but also on thorax and head. This black and yellow coloring gives them a general, and often a particular and very striking resemblance to wasps and hornets for which they are commonly mistaken. Other species are covered with long black and yellow hairs and resemble bumblebees. This resemblance to Hymenoptera is further heightened by their habit of visiting flowers for nectar and pollen.

The Syrphidae may be distinguished readily from all the other Diptera by the so-called *false* or *spurious vein,* which is a vein-like thickening of the wing-membrane between the third and fourth longitudinal veins (radius 4+5 and media 1+ 2) and running through the anterior (radio-medial) cross-vein. It can be distinguished from the true veins by the fact that it is not so clear-cut nor so deep in color and that it ends freely without joining other veins. This false vein is present in all but a very few Syrphidae and not found in the flies of any other family. In the few cases where it is wanting the fourth vein (media 1+2) terminates in the third (radius 4+5) a considerable distance from the margin of the wing. The following combination of characters will always distinguish them.*

Head at least as broad as thorax. Front never excavated, often swollen. Face excavated under the antennæ and projecting below, or with a distinct tubercle near the middle. The antennæ are three-jointed with a dorsal arista or tapering into a terminal style. Ocelli present, three. Tegulæ of moderate size. Empodia not pulvilliform. Bristles (macrochaetae) almost always wanting, never on the head. Second (radius 2+3) and third (radius 4+5) longitudinal veins never forked; fourth longitudinal vein (media 1+2) joins the third before the margin of the wing. Three posterior cells; the anal (cubital) cell long, acutely closed before the border of the wing; basal cells (radial and medial) large; *between the third* (radius 4+5) *and fourth* (media 1+2) *veins and nearly parallel with them there is a false or spurious vein* nearly always present and characteristic of the family. The post alar membranes or squamae with peculiarly-formed, forked and fan-like ciliatión, and an elongate fringed filament-like projection, the *plumula,* from the upper margin of the pteropleura beneath the squamae (Verrall).

How Flower-Flies Live.

Any one of these flies during its entire existence passes through four quite different and distinct conditions or life-stages: The egg; the larva; the pupa; and the adult.

(1) *The Egg.* The eggs of Syrphidae are placed by the parent fly in many different kinds of places, depending on the species, but generally in such a situation that the young when they hatch may easily find at hand an abundance of the par-

*Williston (62, p. xxvi).

ticular kind of food on which they may thrive. Certain kinds, to take an example, glue their eggs to the surface of parts of plants which are infested with plant-lice or aphids. In this case they may be actually placed among the aphids or, more often, on a part of the leaf or stem within easy crawling distance of the aphids. The eggs of other species are laid upon moist filth, in the nests of other insects, in decaying wood, etc., depending on the feeding habits of the forthcoming young.

In whatever situation found, the eggs of Syrphidae have a somewhat characteristic appearance as indicated by Figs. 30-*1, 2, 3;* 31-*61, 62, 63;* 32-*41, 42, 43;* 36-*1, 2, 3;* and 37-*1, 2, 3.* They are chalk-white, shiny, elongate-ovate or subcylindrical with rounded ends. The micropylar end more truncate. Flattened slightly to the surface on which they are deposited, slightly humped above. Commonly about 1 mm. (1-25 inch) long by a third of a millimeter in diameter,—so small that they are seldom noticed yet they can easily be seen by the unaided eye. However, when viewed under a microscope the characteristic thing appears; *viz.*, a delicate and beautiful sculpturing of the shell (chorion) consisting typically of elevated oval areas (*bodies*) separated by depressed areas, but each elevation surrounded by radiating and interlacing, sometimes branched *arms*, also elevated, which they give off into the depressed areas and which often completely cover the latter with a fine elevated network.

(2). *The Larva.* Upon hatching there appears from the egg, not a miniature fly as some might expect, but a very small, slender, headless, footless, blind, creeping maggot, known technically as a *larva*. The exertions of splitting the shell and escaping from the egg may require a brief rest; but very soon the larva seeks out the food-supply. There follows a period of almost constant feeding, covering from one to several weeks, during which the maggot increases many hundreds of times in size and deposits within its body a great excess of fatty material of use in the third stage.

The larvae of the different species are by no means all similar in appearance. In fact they differ so much that no one would suspect some of them of being the young of closely-related flies. All of them agree in being eruciform, slug-like, without true legs and only the most rudimentary of pro-legs or

none. They also agree in lacking a specialized head, the anterior segments being usually bluntly accuminate, and in no way constricted or marked off from the rest of the body. A few filth-inhabiting larvæ have the anterior segments globose and slightly constricted from the succeeding ones making a feebly-differentiated false-head. All the larvæ of Syrphidae carry on aerial respiration through stigmata or spiracles near the anterior and posterior ends of the body,* and lack them on the intermediate segments. *The posterior spiracles are always situated on the ends of two elongate or very short tubes which are fused mesad throughout their length, never forked or divergent,* except very slightly at the tip or in very young larvæ; and consist of three pairs of slit-like spiracles and a pair of circular plates or "buttons." The anterior larval spiracles (Fig. 33-*12;* 34-*2;* 36-*4*) are small, situated dorso-lateral near the anterior end and may be somewhat elevated on cornua or quite sessile. The head-segments bear a pair of short, fleshy, sensory structures corresponding to antennæ and certain chitinized external mouthparts. The oesophagus has also a chitinized cephalo-pharyngeal framework or skeleton. The mouth and anus are terminal or slightly ventrad at the two extremities.

The somites are not clearly differentiated and in some genera, notably *Microdon,* are indistinguishable. Usually they are indicated externally by groups of transverse wrinkles between which groups the body is slightly constricted. But more especially by the presence of a transverse row of specialized vestiture consisting typically of twelve hairs or spines either with or without subtending, conical, wart-like papillæ, called the *segmental spines or elevations* (35, p. 18). Sometimes these spines are very inconspicuous, sometimes instead of the single spine we have a clump of several soft hairs; but in all the larvæ I have examined, except the species of *Microdon,* the segmental vestiture is specialized or differentiated in some way from the other vestiture of the body, the *integumental vestiture.*

Although the segmentation is obscure in this family, for convenience of description I have assumed (35, pp. 18 and 20) that there are twelve somites represented in the larva. I have

*I have so far failed to find anterior spiracles on the larvæ of *Microdon* which I have examined.

considered that there are two head segments cephalad of the anterior spiracles; and that these spiracles are borne on the third or prothoracic segment. On the basis of the segmental spines there are usually eight similar and sub-equal segments caudad of the one bearing the anterior spiracles, and one terminal segment which bears the posterior respiratory process, making twelve in all.

(3) *The Pupa.* When the larva is fully grown, commonly about a half inch in length, it comes to rest in some suitable place in or near the larval habitat and prepares for the transformation to the winged fly. It fastens its caudal segments to a leaf or twig or other support with glue from anal glands, or buries in the ground. Its skin inflates dorsally and laterally, nearly obscuring the wrinkles characteristic of the larva, shortens on the ventral line and becomes much indurated by the deposition of chitin, thus forming the pupa-case or *puparium*. Within this case certain complicated changes take place during which legs and wings and hair and eyes and mouth parts and the other features of a winged fly, like the one that laid the eggs, gradually make their appearance.

Since the pupa is concealed in the puparium throughout this stage, the characteristics readily observable are those of the larval skin which are, except for shape, mostly the same as during the larval period. The tracheæ leading from both anterior and posterior larval spiracles are atrophied during this stage and respiration is provided for by a pair of stigmata which pierce the puparium in the region of the fourth or fifth larval segment. From each of these stigmata a large tracheal trunk leads downward to the prothorax of the developing imago. In some species the pupal respiratory stigmata are much elevated on cylindrical cornua (Figs. 36-*8A*; 37-*6A*); in others they are sessile, exceedingly small and often indistinguishable or apparently wanting (Fig. 30-*7A*). The characteristics of the larval skin, such as anterior and posterior larval spiracles, prolegs and vestiture, usually remain practically unchanged throughout this period.

The coarctate pupa (Fig. 32-*5*, *5f*) is protected by the hard puparium and, within this, a thin, delicate, transparent membrane (Fig. 32-*5a*) encases the developing wings, legs, and other parts of the body. The segmentation and appendages of

the fly are produced very gradually. The legs, mouth-parts and wing-pads differentiate first while the dorsal part of the body and especially the abdomen is still eruciform as in the larva. Antennæ and eyes next take form followed by the segmentation of the abdomen the appearance of the vestiture and the differentiation of the thorax. The hind leg during this stage is bent at the middle of the tibia at an angle of about 150 degrees. The coloration of the adult is well developed sometimes several days before emergence; and in species where the puparium is quite transparent it is often possible to identify the species through the puparium.

(4) *The Adult.* When fully formed the adult pushes off a lid-like portion of the anterior end of the puparium by the dilation of its face and crawls out of the opening so formed. Emergence often requires several hours' time and not infrequently a specimen dies in the attempt to disentangle itself from the puparium. By the time emergence is accomplished the insect has practically assumed the adult form. The principal difference is that the wings are thick, crumpled and folded (Fig. 32-54) and must expand to a much greater area, become flattened instead of bag-like and hardened to form an effective organ of flight. The coloration of the fly is pale and the whole body somewhat soft and worm-like. But within an hour, sometimes, indeed, within a few minutes, the body has become perfectly indurated, the wings completely expanded, and the color-markings fixed to that of the imago.

After emergence the life of the fly is dominated by two impulses, the instinct to feed and the instinct to reproduce its kind. The food of the adult is practically always secured from flowers and consists of nectar and pollen. The flies seem to be strongly influenced by heliotropism or sunlight. They are almost always active in the sunshine and the brighter and warmer the day the more active they become. These facts may be taken advantage of by the person who wishes to collect Flower-flies. The most fruitful collecting is to be found about melliferous flowers and in the sunshine, particularly in very early spring.

Mating may take place on the wing with both sexes actively flying (hovering) and oriented in the same direction, the male uppermost (*Sphaerophoria, Sphegina,* etc.); or the pair may come to rest on foliage, in which case the two are usually facing

in opposite directions, either resting or the male being passively dragged about from leaf to leaf by the female (*Temnostoma*). The process of copulation has been observed to continue for many hours at a time.

The next and final step in the completion of the life-round or life-cycle is oviposition for the next generation. The female, no longer closely attended by the male, hovers about the medium on which the larvæ are to feed settling down at intervals to place the eggs. The terminal segments of the abdomen with the ovipositor are greatly extended and the egg passes between the vulva to its position on leaf, filth, or other medium, according to the habits of the particular species. The eggs may be placed singly and greatly scattered, as in most of the predaceous species; or several may be placed closely side by side (*Melanostoma mellinum*, q. v.); or they may be deposited in great numbers in a mass, as in most of the filth-inhabiting species. In the latter case some of the species seem to rank the eggs in quite regular order; in others they appear to be simply extruded in a pile with little regard to their orientation. Often a gluey substance is passed with the egg which fastens it securely to some surface. Eggs succeed each other commonly at intervals of about a minute.

Habits of the Larvæ.

The habits of the larvæ of Syrphidae, which are remarkably varied, have formed an interesting subject of study for a number of years. Perris in 1870 (41) gave a brief resumé of the modes of life of these larvæ as known to him. Williston, 1886, (62, p. 271), Verrall, 1901, (55, p. 674) and the writer, 1913, (35, pp. 38-42) have amplified and extended this table to include additional habits and species as determined.

I have attempted to outline our present knowledge of the habits of these insects in a logical way in Figure 28. In the first column of this plate is a systematic analysis of the known larval habits. In the second are listed the North American species or genera known to follow any particular habit. And in the third the structure of these larvæ, so far as the writer has personally studied them, is indicated.

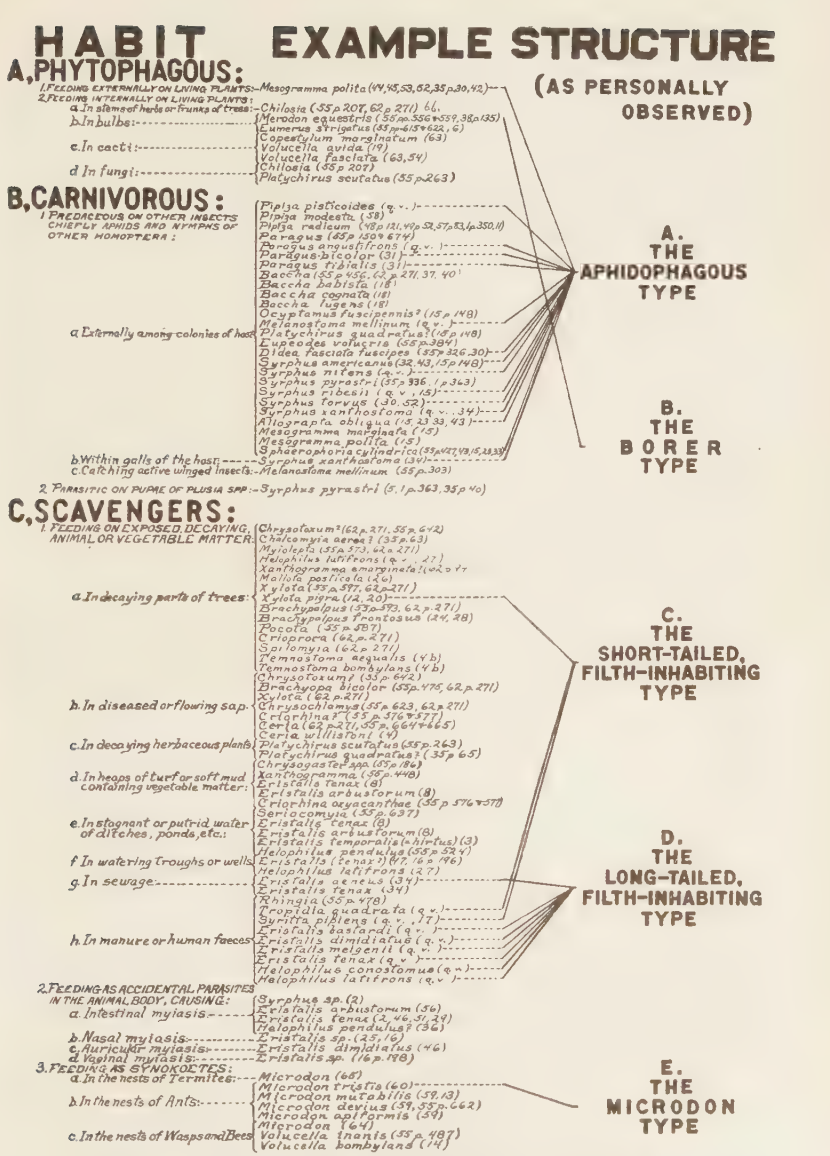
HABIT
EXAMPLE
STRUCTURE
(AS PERSONALLY OBSERVED)
A, PHYTOPHAGOUS:
1. Feeding externally on living plants:- Mesogramma polita (14, 45, 53, 62, 35 p. 30, 42)
2. Feeding internally on living plants:
a. In stems of herbs or trunks of trees:- Chilosia (55 p. 207, 62 p. 271) 66
b. In bulbs:- Merodon equestris (55 no. 556 & 539, 38 p. 135)
Eumerus strigatus (83 pp. 615 & 622, 6)
Copestylum marginatum (63)
c. In cacti:- Volucella avida (19)
Volucella fasciata (63, 34)
d. In fungi:- Chilosia (55 p. 207)
Platychirus scutatus (55 p. 263)
B, CARNIVOROUS:
1. Predaceous on other insects chiefly aphids and nymphs of other homoptera:
Pipiza pistricoides (q. v.)
Pipiza modesta (38)
Pipiza radicum (98 p. 121, 99 p. 52, 57 p. 83, p. 350, 11)
Paragus (85 p. 509 & 674)
Paragus angustifrons (q. v.)
Pargus bicolor (31)
Paragus tibialis (31)
Baccha (55 p. 456, 62 p. 271, 37, 40)
Baccha babista (18)
Baccha cognata (18)
Baccha fugens (18)
Ocyptamus fuscipennis? (15 p. 148)
a. Externally among colonies of host: Melanostoma mellinum (q. v.)
Platychirus quadratus? (15 p. 148)
Eupeodes volucris (55 p. 384)
Didea fasciata fuscipes (85 p. 326, 30)
Syrphus americanus (32, 43, 15 p. 148)
Syrphus mitens (q. v.)
Syrphus pyrastri (35 p. 336, 1 p. 343)
Syrphus ribesii (q. v., 15)
Syrphus torvus (30, 52)
Syrphus xanthostoma (q. v., 34)
Allograpta obliqua (15, 23, 33, 43)
Mesogramma marginata (15)
Mesogramma polita (15)
Sphaerophoria cylindrica (35 p. 427, 19, 15, 23, 33)
b. Within galls of the host:- Syrphus xanthostoma (30)
c. Catching active winged insects:- Melanostoma mellinum (55 p. 303)
2. Parasitic on pupae of Plusia spp.:- Syrphus pyrastri (5, 1 p. 363, 35 p. 40)
A. THE APHIDOPHAGOUS TYPE
B. THE BORER TYPE
C, SCAVENGERS:
1. Feeding on exposed, decaying, animal or vegetable matter:
Chrysotoxum? (62 p. 271, 55 p. 642)
Chalcomyia aerea? (35 p. 63)
Myiolepta (35 p. 373, 44 p. 271)
Helophilus latifrons (q. v., 27)
Xanthogramma emarginata (42 p. 47
Mallota posticata (42)
Xylota (35 p. 417, 62 p. 271)
a. In decaying parts of trees:
Xylota pigra (12, 20)
Brachypalpus (35 p. 373, 62 p. 271)
Brachypalpus frontosus (24, 28)
Pocota (35 p. 418)
Criorhina (62 p. 271)
Spilomyia (62 p. 271)
Temnostoma aequalis (46)
Temnostoma bombylans (46)
Chrysotoxum? (35 p. 642)
Brachyopa bicolor (35 p. 475, 62 p. 271)
Xylota (62 p. 271)
b. In diseased or flowing sap:
Chrysochlamys (55 p. 623, 62 p. 271)
Criorhina? (35 p. 576 & 577)
Certa (62 p. 271, 35 p. 664 & 665)
Ceria williston (4)
c. In decaying herbaceous plants:
Platychirus scutatus (55 p. 263)
Platychirus quadratus? (35 p. 65)
Chrysogaster spp. (85 p. 186)
d. In heaps of turf or soft mud containing vegetable matter:
Xanthogramma (36 p. 448)
Eristalis tenax (8)
Eristalis arbustorum (8)
Criorhina oxyacanthae (35 p. 576 & 578)
Sericomyia (35 p. 637)
e. In stagnant or putrid water of ditches, ponds, etc.:
Eristalis tenax (8)
Eristalis arbustorum (8)
Eristalis temporalis (=hirtus) (3)
Helophilus pendulus (55 p. 524)
f. In watering troughs or wells:
Eristalis (tenax) (87, 16 p. 96)
Helophilus latifrons (27)
g. In sewage:
Eristalis aeneus (34)
Eristalis tenax (34)
Rhingia (55 p. 478)
Tropidia quadrata (q. v.)
Syritta pipiens (q. v., 17)
Eristalis bastardi (q. v.)
h. In manure or human faeces:
Eristalis dimidiatus (q. v.)
Eristalis meijerei (q. v.)
Eristalis tenax (q. v.)
Helophilus conostomus (q. v.)
Helophilus latifrons (q. v.)
C. THE SHORT-TAILED, FILTH-INHABITING TYPE
D. THE LONG-TAILED, FILTH-INHABITING TYPE
2. Feeding as accidental parasites in the animal body, causing:
Syrphus sp. (2)
a. Intestinal myiasis:- Eristalis arbustorum (36)
Eristalis tenax (2, 46, 51, 29)
Helophilus pendulus? (36)
b. Nasal myiasis:- Eristalis sp. (25, 16)
c. Auricular myiasis:- Eristalis dimidiatus (46)
d. Vaginal myiasis:- Eristalis sp. (16 p. 198)
3. Feeding as synoekotes:
a. In the nests of Termites:- Microdon (68)
Microdon tristis (60)
b. In the nests of Ants:- Microdon mutabilis (59, 13)
Microdon devius (59, 55 p. 662)
Microdon apiformis (59)
Microdon (64)
c. In the nests of Wasps and Bees:- Volucella inanis (55 p. 487)
Volucella bombylans (14)
E. THE MICRODON TYPE
LARVAE OF SYRPHIDAE

Fig. 28. An outline of the known habits and structure of the larvae of Flower-flies. The numbers following the names of species refer to papers in the bibliography.

Although the larva of each species will doubtless be found to vary in a measurable degree or perceptible way from every other species, it appears that these various larvæ can be assembled into five groups, collectively distinct from each other, while the larvæ in the group have many important points in common. I have, therefore, separately described them and shall, for convenience, speak of them as *types* of larvæ.

Structure of the Larvæ.

I. The aphidophagous type of larva.

Body sub-cylindrical, flattened ventrally and much attenuated anteriorly. Posterior respiratory process short, the spiracles either straight or convoluted, never denticulated. Inter-spiracular ornamentation consisting of bare hairs, nodules, ridges or lamellæ, never of plumose hairs. Mouthparts of two Λ*-shaped jaws. Segmental hairs single. If prolegs present, without specialized vestiture. Anterior pupal respiratory cornua apparently wanting.*

This type of larva, named from the most characteristic habit, has the posterior larval spiracles at the apex of two very short, rigid, heavily chitinized, cylindrical breathing tubes which are fused mesad throughout their length (except in very young larvæ) never bifurcated except very slightly at the extreme tip; situated terminally or on the dorsum of the depressed twelfth segment. This short double tube bears on its tip three pairs of slit-like *spiracles* elevated on radiating carinæ, usually nearly straight, never branched or denticulate; and a more or less prominent *circular plate* or "button." The interspiracular ornamentation (between the spiracles) may consist of hairs, spines, nodules, ridges or perpendicular plates,—never of plumose hairs. The anterior spiracles are sessile or nearly so, rounded or lunate, very small. The body is elongate, slender, tapering to a point at the anterior end, somewhat flattened ventrally.

The body is wrinkled transversely and the wrinkles or folds grouped in such a way as to imperfectly mark the body segments, which are further indicated by the *segmental spines*, a transverse row of twelve hairs, spines, or bristles on each segment, sometimes obscure, sometimes very prominent, but always present and differentiated from the remaining *integumental* vestiture.

The mouth-parts consist of two V-shaped, jaw-like pieces working vertically and associated spines or hooklets; which, with the terminal anterior segments, are strongly retractile.

The integument is tough but thin and more or less transparent, either glabrous and papillose or closely set with minute stiff hairs

(the integumental vestiture). The colors are various but commonly some shade of green, brown or pink, striped or blotched with white or black. Usually the dorsal blood-vessel (heart-line) shows as an interrupted black mid-dorsal line throughout most of the length.

In the pupa stage this type has a somewhat characteristic shape,—subovate, bulbous in front and tapering to the posterior respiratory process (which retains its larval characteristics) behind.

It is separated from the other types I have examined in lacking a conspicuous pair of anterior (prothoracic) stigmata developed and pushed through the puparium for pupal respiration. These pupal respiratory cornua appear to have been heretofore overlooked. They are so minute that even when one knows they are present it is only with the greatest difficulty that they can be demonstrated. In *Melanostoma mellinum* (q. v.), a species with unusually transparent integument, they can be located readily because the tracheæ leading from them are easily visible.

II. THE BORING TYPE OF LARVA.

Body nearly cylindrical, less attenuated anteriorly. Posterior respiratory process short, the spiracles convoluted, inconspicuous; circular plate sunken. Inter-spiracular ornamentation of short, palmately-branched, plumose hairs. Mouth-parts fitted for rasping, of two ventrally directed hooks uniting basally into a mouth-hood. Segmental hairs single.

This type is represented in my collection only by the larvæ of *Merodon equestris,* collected from Narcissus bulbs in British Columbia, for which I am indebted to Dr. C. Gordon Hewitt, Dominion Entomologist. These larvæ are superficially much like the first type but the body is more nearly cylindrical, less flattened ventrally, and less attenuated anteriorly. Segmental hairs single, prominent. The posterior respiratory process has lost nearly all trace of its double nature and appears as a truncated cone. The circular plates are deeply sunken and occupy a central rather than a dorsal position. The spiracular slits are very inconspicuous and are irregularly and much convoluted. The inter-spiracular ornamentation consists of short, palmately-branched, plumose hairs.

The anterior three body segments are directed ventrad and terminate in the mouth-parts. The latter entirely different from aphidophagous species, consisting of two black, heavily-chitinized, rasping, recurved hooks, each with a small, inner, basal spur, fused basad to form a heavy, black, ventrally-concave hood beneath which is the mouth opening.

I have not seen the pupa of this type.

III. THE SHORT-TAILED FILTH-INHABITING TYPE OF LARVA.

Body cylindrical with the anterior segments modified into a "false-head." Posterior respiratory process short, the spiracles convoluted and denticulated. Inter-spiracular ornamentation of short, palmately-branched, plumose hairs. No external mouth-parts but a chitinized mouth-hood. Three pairs of lateral, fleshy, conical protuberances on segment twelve. Segmental hairs triple or quadruple, flexible, inconspicuous. Rudimentary prolegs. Pupal respiratory cornua prominent, morel-shaped.

This type of larva is superficially like the Boring Type, but the anterior three or four segments instead of being accuminate are rounded out, globose, as broad as, or broader than, the succeeding segments, and somewhat separated from them by a slight neck-like constriction to make a kind of *false head*. There are no external, chitinized mouth-parts, the mouth opening being covered by a moderately-chitinized, striated mouth-hood, the termination of the cephalopharyngeal skeleton; and guarded on each side by a poorly defined, piliferous fold of skin.

The posterior respiratory process shows its origin from two tubes; the circular plate is on a level with the apex of the tube; and the slit-like spiracles which are more prominent are convoluted and also ornamented with more or less numerous lateral projections or denticles. The inter-spiracular ornamentation consists of plumose, palmately-branched hairs. The segmental vestiture consists of clumps of about three or four fine, flexible hairs, a little longer than the integumental vestiture, and all arising together. The larvæ have seven pairs of prolegs along the ventral side of the body, which consist of elevated folds of the body-wall over which the integumental vestiture is specialized into heavier, rigid and retrorse hooks of varying size.

This and the following types of larvæ differ strikingly from the first in producing for the pupa stage a pair of very conspicuous tubular, anterior respiratory cornua, studded with minute nodules and connected with the nymphal prothorax, as in the first type, by large tracheal trunks. These cornua in the three species examined are more or less mushroom- (morel-) shaped.

IV. THE LONG-TAILED (RAT-TAILED) FILTH-INHABITING TYPE.

Body cylindrical with a false head, and long tail. This posterior respiratory process elongate, telescoping, flexible, at least half as long as the body. The spiracles on its end entirely inconspicuous. Inter-spiracular ornamentation of single, long, plumose hairs. No external mouth-parts except the mouth-hood. Segmental hairs double or triple, flexible, inconspicuous.

Rudimentary prolegs present. Anterior pupal respiratory cornua elongate, cylindrical, very prominent.

This type is most closely allied to the third type but differs from it and from all the others in the remarkable elongation of the posterior respiratory organ, which, in these species, is tube-like, three-jointed and telescopic; and may be extended to several times the length of the body although commonly contracted to about body-length. This remarkable and highly specialized organ enables the larva to carry on aerial respiration while feeding at various depths beneath the water level. It is of two tubes fused mesad and enclosing two tracheæ which open at the tip. The inter-spiracular ornaments consist each of a single, unbranched, but plumose, long hair instead of a palmate group of short plumose hairs as in the two previous types. The prolegs are similar to type III. The anterior larval spiracles are unusually conspicuous, borne on a pair of cornua which are capable of considerable elevation although usually rather closely retracted.

The shape of the body is sub-cylindrical with the anterior segments forming a false head, and the mouth-hood as in type III. The terminal segment tapers strongly into the respiratory process. The integument is very flexible and transparent; segmental hairs double, similar to type III. The anterior pupal cornua are longer than in type III and nearly cylindrical, the enlarged distal part much longer than the basal stalk, hence the whole less mushroom-shaped.

V. THE MICRODON TYPE OF LARVA.

Body hemi-spherical; the flat surface ventrad, with a row of spines around its margin; dorsum reticulated. Posterior respiratory process short, the three spiracles on each half together making nine loops, convex outwardly and denticulated on their outer margin. Inter-spiracular ornamentation of non-plumose fine hairs. Mouthparts consisting of a ventral Λ-shaped jaw and two dorsal pieces placed Λ-shaped, but not fused at the apex. Segmental hairs and prolegs wanting. Anterior larval spiracles apparently wanting. Pupal respiratory cornua morel-shaped.

The larvæ of this genus are very aberrant and superficially show no relationship with the other larvæ of Syrphidæ, differing strikingly from all the others in shape. Instead of the elongate, sub-cylindrical body we have a nearly hemi-spherical body. The outline is short elliptical, the ventrum very much flattened forming a ventral sole around the margin of which is a circlet of ornamental spines. Dorsum almost uniformly rounded up. Mouthparts open in a longitudinal slit on the cephalic part of the ventral sole. Posterior respiratory process dorso-caudad, short, tubular, but with some indication of its double nature; circular plate medio-dorsad. The spiracular slits each of three,

outwardly directed loops, denticulated only on the outer side, almost arborescent in appearance but still divisible into three pairs. The interspiracular ornamentation of small, delicate, non-plumose hairs. No anterior larval spiracles have been demonstrated.

In place of the transverse folds or wrinkles on the dorsal surface, it is evenly convex and beautifully reticulated with lines of papillæ. I find no evidence of the segmental hairs.

The pupal respiratory cornua are similar to those of type III being much shorter than in type IV.

Economic Importance of the Larvæ.

The principal economic importance of the larvæ is four-fold, two of these relationships being beneficial and two of them detrimental to human interests.

A. BENEFICIAL HABITS.

1. *As predators.* By far the most important economic bearing of Syrphidae arises from the predaceous habit of many common species. Of the prey affected, aphids compose probably ninety-nine per cent. *Coccidae* and the young of *Aleyrodidae, Jassidae, Psyllidae and Membracidae* are also attacked, and occasionally even active winged insects such as Diptera may be caught (55, p. 311) or the larvæ of other Syrphidae devoured.

With the vast majority of species there is no close restriction to particular species of prey; although a few species such as *Didea fasciata* and *Pipiza pisticoides* have been found among only one or a few species of aphids.

For the most part the service of these insects is in preventing the abnormal increase of the various injurious species of aphids rather than in exterminating the colonies in any particular place; although the latter result is by no means uncommon. Their value is ordinarily due to their very uniform distribution and constant occurrence, rather than to tremendous numbers at any time or place. Nevertheless, instances of the occurrence of enormous numbers of them are not lacking. Perhaps the most notable of such records is that by W. G. Johnson (23, p. 97) regarding the abundance of larvæ during an outbreak of the pea-louse (*Macrosiphum pisi* Kalt.) in southern Maryland in 1899. I quote from Mr. Johnson as follows:

"The real importance of the Syrphus-fly larvæ in the reduction of the species [the pea-louse] was shown beautifully in southern Maryland, where they were so abundant the first and second weeks in June as to almost completely destroy the lice." And quoting further from his correspondent: "'The insects (lice) started to disappear last week and are now about all gone . . . The last few days I packed, the separators sieved out about 25 bushels of green worms [larvæ of Syrphidæ, chiefly *Allograpta obliqua*] which no doubt proves that they destroyed the lice.'"

Mr. Johnson states further that the Syrphid-flies did not save the crop that year but calls attention to their probable value in relation to future ravages of the pest. A conservative estimate shows that twenty-five bushels of the larvæ of *Allograpta obliqua* could scarcely represent less than 3,000,000 individuals. Presuming that the larvæ lived ten days and ate on the average twenty aphids a day (which I believe also to be a conservative estimate) such a multitude of larvæ would be responsible for the destruction of over half a billion aphids.

Another example of the extermination of aphid colonies by these predaceous larvæ is afforded by the attacks of *Pipiza pisticoides* on the Woolly Apple Aphis. These aphids became evident as above-ground colonies on apple, at Orono, about the first of August. At the same time several species of Syrphid larvæ also made their appearance among them, chiefly the larvæ of *Pipiza*. Shortly the Woolly Apple Aphis began to disappear, the aphids becoming scarcer and scarcer and the predaceous larvæ more and more evident, until by early September I found myself with many larvæ on hand and almost no aphids anywhere to be found as food for them. Doctor Patch tells me she has found this a rather common experience; and that year after year, the colonies of Woolly Apple Aphis on apple have practically disappeared in the presence of these predaceous larvæ, by mid-September. See also page 224.

The relentlessness of these enemies of aphids is illustrated in a peculiar way by the experience of the Station Entomologist, who for a number of years has been studying the aphids of the State. It is an altogether too common experience that aphid material mailed to her for study has been absolutely consumed *en route* by Syrphid larvæ, inadvertently introduced into the package by the correspondent.

Hardly a colony of aphids can be found that is not being preyed upon by from one to half a dozen species and from one to dozens of individuals. They kill the individual aphids outright but on account of the rapid rate of reproduction of the latter the colony usually exists for some time at least.

I have been interested in getting some definite data as to the capacity of these larvæ for devouring their prey.

Specimens of *Aphis brassicae* proffered to a four-day old unfasted larva of *Syrphus americanus* were devoured at the following rate: Four minutes and 30 seconds, 2 minutes, 1 minute, 1 minute, 30 seconds, 3 minutes and 15 seconds, 2 minutes, 1 minute and 45 seconds, and 1 minute and 30 seconds; a total of nine aphids in seventeen and a half minutes (32, p. 481). In this test the aphids were touched to the mouth-parts of the larva as rapidly as the previous skin was discarded. It was thought that this represented an abnormal rate of feeding. Last summer the larva of *Syrphus nitens* was observed while feeding *normally* on the large aphids *Pterocomma flocculosa*. During a period of twenty minutes, twenty-one aphids were caught and destroyed. The larva had not been kept away from food nor were the aphids supplied for it or the process in any way hurried or artificial.

How much longer feeding at this rate may continue or how frequently such periods of rapid feeding may succeed each other, observations have not yet shown. However, it seems certain that the number of aphids destroyed by a single specimen during its larval existence of one or two weeks or longer must be very considerable.

Particularly when we consider the enormous numbers of progeny which may be prevented from developing by the destruction of even a single agamic female, the value of these agricultural benefactors may be more correctly judged. A point of great importance in this respect is that the Flower-flies infest the aphid colonies very early in the establishment of the latter; indeed, sometimes the Syrphid eggs are deposited on a plant in advance of its infestation by the aphids; so that numerous voracious larvæ may be awaiting the first appearance of the stem-mother and her progeny.

Another important point which enhances the destructive powers of the Syrphid larvæ, is that they eat—not the entire aphid—but only the soft and rapidly digestible body-contents.

"These aphidophagous larvæ, although frequently found entirely surrounded by an abundance of prey, are very often obliged to search about for food. Their characteristic, looping movements are very familiar to many people. When used for progression alone, these movements may be very rapid. Their progress is very similar to that of a 'measuring-worm' though the body is not so long. When the larva is searching for food, the anterior half or two-thirds of the body is raised in the air, very much extended, and lashed from side to side. It is then attached and the posterior parts pulled up, when the movement is repeated. Thigmotropism, and not chemotropism, seems to be involved in locating food. Hungry larvæ frequently pass by aphids so closely as almost to touch them, and go on in search of others. When a suitable aphid is found the larva frequently grasps it first by the leg or antenna and clings to this appendage until the thorax or abdomen can be reached. The mouth-parts are firmly attached to the body, the body-wall is punctured, and the aphid usually lifted high in the air. Then begins a process of slowly picking and sucking out all the body contents, which may continue from a fraction of a minute to more than an hour (in the case of very young larvæ). The action of the mouth-parts is very characteristic and very well adapted to the needs of the case. Many different muscles, which have their origin on the body-wall in the region of the head, are inserted upon the cephalo-pharyngeal skeleton, the jaws, and the mouth-hooklets. Some of them operate the framework in and out like a battering ram. Others at the same time open and close the jaws. The anterior two or three segments are inserted completely within the body wall of the aphid. The jaws are directed into every corner of the body and even into the bases of the appendages as they pick and suck out the soft contents. The skins, absolutely empty, are then discarded by retraction of the segments, the hairs or spines on those outside serving readily to dislodge the skin. These dead skins usually drop down or blow away but may sometimes be seen in numbers on the host-plant." (The Author, 35, pp. 26, 27).

2. *As Scavengers.* The other important way in which the larvæ of Syrphidae are beneficial to human interests is by their activities as scavengers. Considerable quantities of dead animal and vegetable matter are in this way reduced to simpler compounds, more readily assimilated by plants; and certain materials which are obnoxious, and may be a menace to health, are transformed to innoxious forms.

To quote from Comstock (10, p. 415):

"Although the habits of these creatures, which revel in all kinds of filth are very disgusting, we cannot help admiring that arrangement by which a mass of filth, instead of being left to poison the atmosphere, is transformed into myriads of living beings whose swift flight and delicate forms lend life and beauty to the landscape."

Happily, the breeding of these flies in excrement ordinarily causes no menace to human health; because (unlike the house-fly) they do not commonly visit human habitations and human foods, but confine their explorations as adults almost exclusively to flowers out-of-doors.

B. INJURIOUS HABITS.

Few large families of insects are on the whole less detrimental to human interests than the Syrphidae. Yet it is incorrect to state, as some of our text-books do, that none of the species are injurious; for although the family includes no well-known pests in this country, there are two important ways in which the Flower-flies are injurious in the larval stage.

1. *As Crop-Pests.* The few species which are phytophagous are occasionally seriously destructive to crops. The most notable of them in America is *Toxomerus** *politus* which has come to be known as the Corn-feeding Syrphid-fly. This species has been reported as feeding on corn in abundance as follows: New Jersey, 1885 (44), 1899 (53) and 1913 (42); Florida, 1886 (44); Missouri, 1889 (45); Delaware, 1900 (50); and North Carolina, 1913 (35). I found them (pupæ) abundant on field corn (in the axils of the leaves) at the Ohio State University farm, September, 1915; and Professor Z. P. Metcalf sent me larvæ and pupæ (attached among the glumes on the tassels) from West Raleigh, North Carolina, in late August, 1915 with the statement that they were again plentiful there.

The species is evidently widespread and common on corn, but only a few cases are known where its attacks were considered serious; notably in Florida and Missiouri (*loc. cit.*). They feed on pollen grains and on the saccharine cells at the axils of the leaves. The former habit might seriously interfere with fertilization and the consequent yield of grain, if the larvæ were abundant; while the latter attack was stated to produce a wilting and browning of the lower leaves similar to the injury from chinch-bugs. This species is not yet recorded from Maine but will probably be found to occur within the State. The puparia are often heavily parasitized which may explain why they are not oftener seriously destructive.

**Mesogramma.*

In Europe the larvæ of *Merodon equestris* (55, p. 556) and *Eumerus strigatus* (55, p. 615) are pests of flowers such as Narcissus and Amaryllis, and of the onion among vegetables. The larvæ burrow into, and promote the decay of, the bulbs of these plants; in certain instances having destroyed thousands of plants. They have been introduced into North America and are transferred from place to place in infested bulbs, and there is reason to fear that their range will continue to be extended and that they may become serious pests in this country.

On July 25, 1916, a number of the adults of each of these two species was taken about blossoms in a nursery at Bar Harbor. No damage by the larvæ had been recognized by the nurserymen, but the number of adults present indicates that the species are established in the State or are quite likely to become so.

2. *As Transitory Animal Parasites.* The fourth important way in which larvæ of Flower-flies affect us is by their occasional occurrence in the living human or animal body and the accompanying disturbances or destruction of tissues. Myiasis is known to be produced by Syrphidae in four ways: First, by their presence in the alimentary canal (intestinal or gastric myiasis); secondly, by their introduction to the nasal cavities (nasal myiasis); thirdly, by their introduction to the auditory cavities (auricular myiasis); and fourthly, by their introduction into the vagina (vaginal myiasis).

The first of these is the more common. Probably it not infrequently occurs and is not recorded. On the other hand, many reported cases of larvæ having been passed from the bowel are doubtless erroneous due to the stools having become infected after passage. Hall and Muir, 1913, (16) have summarized the published data relative to myiasis due to Syrphidae and described an additional case. It appears that there are certain authentic cases on record where such larvæ have been passed alive, sometimes as many as twenty or thirty at a time. The presence of the larvæ in the intestine caused some of the following symptoms: Intestinal pains, vertigo, nausea, vomiting, constipation, headache, nervousness, weakness and emaciation.

The species known to be concerned in such infestation are *Eristalis tenax* (2, 46, 51, 29), *Eristalis dimidiatus* (46), *Eristalis arbustorum* (56) and possibly *Helophilus* (*Musca*) *pen-*

dulus (36). These are all larvæ of the long-tailed, filth-inhabiting type which live normally in sewage, putrid or stagnant water, in ditches or even in watering troughs (27), and wells (47; 16, p. 5).

The source of infection in certain cases has been explained as follows: By ingestion of eggs laid on cream, sour milk or cheese; by ingestion of eggs or larvæ in drinking water from springs, contaminated by the drainage from compost heaps or from stagnant pools or ditches; by eating water-cress or overripe fruit in which larvæ may be present; or by deliberate ingestion on the part of children. Any of these methods seems possible and all, except the first and the last, quite probable.

It is not difficult, as pointed out by Wagner (56), to see how these larvæ are able to exist in the alimentary canal, where the conditions would not differ greatly from their normal habitat in fæces. The food is similar, plenty of air is supplied by swallowing, and the mephitic gases are not greatly different. It is not quite clear how the larvæ manage to resist passage for many weeks, as certain cases indicate. They have no hooks which would enable them to attach to the intestinal wall unless, indeed, it be the minute ones on the prolegs, which seem inadequate.

Austen (2) reports two cases of intestinal myiasis due to the larvæ of *Syrphus*, which are not so easy of explanation; because what is known of the larval habits of this genus does not indicate a ready source of infestation, nor a likelihood that these larvæ would readily adapt themselves to the conditions of the alimentary canal.

The other kinds of myiasis due to Syrphidae are exceedingly rare. Leidy (25) has recorded a case of a rat-tailed larva stated to have been removed from the nasal cavity; Austen (2) a case of the invasion of the external auditory meatus by a *Syrphus* larva, resulting in pain and deafness; and Hall and Muir (16) record a case, reported to the Bureau of Animal Industry, U. S. Department of Agriculture, from Maryland in 1909, where eight larvæ of *Eristalis* were stated to have been passed in a jelly-like substance from the vagina of a cow. The source of infestation in such cases as these is doubtless oviposition by the fly directly in these natural cavities of the body; especially if the latter were in a diseased or uncleanly condition.

In this connection, I wish to emphasize the practical impossibility, at our present state of published knowledge, of referring larvæ found in such circumstances to a definite species, or even to the genus, unless specimens are reared to the adult. It seems to be the custom to refer any rat-tailed larva to *Eristalis tenax*, or at least to the genus *Eristalis*. Such records, unless based on adults reared from the larvæ, must, it seems to me, be discarded as of no specific importance. I am working on the problem of separating these different species in the larval stage, and have examined a dozen species of rat-tailed larvæ belonging to several genera, the separation of which is exceedingly puzzling and difficult, and any one of which might easily be mistaken for the larva of *Eristalis tenax*.

Other biological relations of the larvæ, of more or less economic importance, may arise from their association with other insects, in aphid colonies, or in the nests of colonial insects; and with their predaceous and parasitic enemies.

Economic Importance of the Adults.

While the principal economic importance of Syrphidæ arises from the habits of the larvæ, the adults are by no means devoid of importance in this respect. The adults, so far as known, feed almost exclusively on the nectar and pollen of flowers or the honey-dew of insects. Anyone who has observed the tremendous numbers of these flies which mingle with Hymenoptera about all sorts of melliferous flowers, will be able to appreciate their importance in the cross-fertilization of entomophilous plants. All sorts of fruit and shade trees, wild and cultivated flowers, and certain field and garden crops, are regularly visited by these flies. Some of the flies, which possess an abundant vestiture, often of spurred and branched hairs, are very admirably adapted for the carrying of pollen. This is a subject deserving of careful observation. But in the absence of much definite data it seems safe to ascribe to this family a very large share of credit for this beneficient work, which is usually attributed to Hymenoptera alone.

Practical Measures.

Since the above analysis shows that the economic importance of the Syrphidæ is overwhelmingly beneficial, one is naturally desirous of knowing what could be done to favor, or foster them and increase their numbers.

1. The first thing to be done it seems to me is to educate people and especially agriculturists to discriminate between these Flower-flies and stinging Hymenoptera. The writer knows from personal observation that many of these beneficial insects are constantly being killed as "sweat-bees" under the impression that they can sting. Whereas, *they are absolutely unable to harm the person in any way; and furthermore, are, both as larvæ and adults, (with the exception of a very few species) among the farmer's most valuable animal friends.*

There are several simple ways in which these two groups can easily be distinguished in spite of the great resemblance in color, form and habit. *If the insect is flying*, the Flower-fly can be recognized by its distinct manner of flight, which has given the group the name of "Hover-flies." They constantly poise in the sunlight, or about flowers, remaining suspended in one place for a considerable time without any apparent movement of the body, the wings beating so rapidly as to be practically invisible; then dart away and quickly return, the body always in a tense horizontal position. Bees, when flying, habitually weave back and forth or bob up and down. On closer inspection most of the species can be distinguished by the shorter antennæ ("feelers") which are not easily seen in flight; while the antennæ of the bee are usually visible in front of the head. *If the insect comes to rest,* the Flower-fly is apt to keep its wings partly spread, the bee or wasp to fold them closely or cross them at the tips. *If you have the insect in your hand*, see if the wings on one side can be separated into two readily. The bees have two pairs of wings hooked together, but easily separable; the Flower-flies of course have only one wing on a side. Back of the base of the wing in the Flower-flies is a small knobbed thread (Fig. 29-4) visible to the naked eye on very careful examination, wanting in the Hymenoptera. And, finally, if a hand lens is available look for the false vein (Fig. 34-7) on the wing, which is the most distinctive characteristic of the Syrphidæ.

2. Not only should the adults be spared but the larvæ (Figs. 29-*1*; 30-*6*; 34-*1*) on plants, among aphids, should be given careful protection. Too often they are killed under the supposition that they are damaging the plant. The figures and descriptions should enable one to distinguish these larvæ; but, if there is any doubt, careful observation will usually be rewarded by seeing one of them attack and devour an aphid.

3. The writer, with the assistance of Mrs. Cleo Fouch Metcalf, is investigating the effect of contact insecticides, such as are used for plant-lice, on these predaceous larvæ, in the hope that an effective spray for the aphids may be found which will not destroy the larvæ. In this way the latter might be left on the plants to seek out and destroy any aphids which escaped the spray, and thus tend to make the control measures perfect. The investigation has not gone far enough to justify conclusions, but it may be said that in laboratory tests a solution of Black Leaf 40*, 1 to 1000 of water with soap added, killed every aphid and only a small percentage of the larvæ. The effect of this insecticide on the larvæ under field conditions will be further observed.

4. During late summer and autumn, especially, a large percentage of the puparia of Flower-flies are parasitized by a small wasp which kills them. Such puparia can be easily told, after a little experience, by the fact that they do not completely inflate dorsally and soon become darker in color than normal. Much good could be done by careful observers in destroying such parasitized puparia wherever found.

Species Reared in the State.

During the summer of 1915 at this Station, I succeeded in rearing from eggs or larvæ twenty species of Syrphidæ, nine of which have apparently not previously been described in the immature stages. These species fall into three of the structural types of larvæ already described, as follows:

*Made by the Kentucky Tobacco Product Co., Louisville, Kentucky.

I. *Aphidophagous Species.*

Paragus angustifrons Loew.
Pipiza pisticoides Willist.
Melanostoma mellinum Linné.
Sphaerophoria cylindrica Say.
Sphaerophoria sp.
Syrphus sp.
Syrphus americanus Wied.
Syrphus ribesii Linné.
Syrphus torvus O. S.
Syrphus xanthostomus Willist.
Syrphus nitens Zett.
Didea fasciata Macq. var. fuscipes Loew.

II. *Short-tailed, Filth-inhabiting Species.*

Tropidia quadrata Say.
Syritta pipiens Linné.

III. *Long-tailed, Filth-inhabiting Species.*

Eristalis bastardii Macq.
Eristalis dimidiata Wied.
Eristalis arbustorum Linné.
Eristalis tenax Linné.
Tubifera lineata Fabr. (Helophilus conostoma Willist.)
Tubifera trivittata Fabr. (Helophilus latifrons Loew.)

The Short-tailed and Long-tailed Filth-inhabiting species were, all except the last species, reared from decomposing human fæces at the mouth of a sewer. *Tubifera trivittata* (*Helophilus latifrons*) was breeding in old and dried, but recently water-soaked, droppings of cattle, and soft black mould about stumps in an old stumpy pasture where heavy rains had left numerous pools of shallow water.

The aphidophagous species named above and others not determined were found preying on 33 species of Aphididae and two species of Psyllidæ as follows:

List of Homoptera* Attacked by Syrphidae in Maine as Observed in 1915.

APHID.	HOST PLANT.	SYRPHID.
Aphis viburnicola	Viburnum opulus	*Syrphus ribesii*
		Sphaerophoria cylindrica
Aphis viburniphila Patch mss.	Viburnum opulus	
Aphis cardui	Plum	*Syrphus* sp.
		Sphaerophoria sp.
Aphis cerasifolii	Prunus virginiana	*Sphaerophoria cylindrica*
		Syrphus sp.
Aphis pomi	Apple	*Syrphus americanus*
Aphis spiraecola	Spiraea	*Syrphus torvus*
		Sphaerophoria sp.
Aphis spiraephila	Wild Spiraea	*Paragus angustifrons*
Aphis sanborni	Flowering Currant	*Paragus angustifrons*
		Sphaerophoria sp.
Aphis rumicis	Syringa	*Sphaerophoria cylindrica*
Aphis rumicis	Evonymus alatus	
Aphis rumicis	Broad-leaf Dock	
Aphis helianthi	Cornus	*Sphaerophoria cylindrica*
Aphis cornifoliae	Cornus	*Sphaerophoria* sp.
Macrosiphum rosae	Rose	
Macrosiphum solanifolii	Rose	*Sphaerophoria cylindrica*
Macrosiphum rudbeckiae	Goldenrod	
Macrosiphum sp.	Anaphalis margaritacea	
Myzus cerasi	Plum	
Myzus cerasi	Wild Cherry	*Syrphus* sp.
		Sphaerophoria cylindrica
		Sphaerophoria sp.
Myzus cerasi	Prunus sp.	*Sphaerophoria cylindrica*
Myzus persicae	Rape	*Melanostoma mellinum*
		Sphaerophoria cylindrica
		Sphaerophoria sp.
Myzus sp.	Currant	
Rhopalosiphum nymphaeae	Plum	*Syrphus ribesii*
		Syrphus sp.
		Sphaerophoria cylindrica
Rhopalosiphum nabali	Prenanthes sp.	
Phorodon humuli	Plum	*Syrphus ribesii*
		Syrphus torvus
		Syrphus sp.
		Sphaerophoria cylindrica
Pterocomma flocculosa	Willow	*Syrphus nitens*
		Syrphus americanus
		Lidea fasciata fuscipes
Siphocoryne xylostii	Snowberry	
Symdobius oblongus	White Birch	*Syrphus americanus*
Chaitophorus populifoliae	Poplar	*Syrphus ribesii*
Chaitophorus sp.	Willow	
Schizoneura americana	Elm (Curl)	
Schizoneura lanigera	Apple	*Pipiza pisticoides*
Tetraneura graminis	Elm (Cock's Comb Gall)	
Prociphilus corrugatans	Amelanchier canadensis	
Prociphilus fraxinifolii	Ash	*Syrphus* sp.
Thecabius patchii	Populus balsaminifera	
Hamamelistes spinosus	Birch	*Syrphus ribesii*
PSYLLID.		
Psylla striata Patch	Birch	
Psylla cerasi Patch	Prunus Pennsylvanica	

* Identifications by Dr. Edith M. Patch, Entomologist.

Descriptions of Life-Stages and Life-Histories of Maine Species.

Pipiza pisticoides Williston.

This species is one of the most important if not *the* most important natural enemy of the Woolly Apple Aphis (*Schizoneura lanigera*) about Orono. The larvæ were plentiful among the above-ground colonies of this aphid, especially during August. The eggs are laid by adults, doubtless of a spring generation (developing among one of the elm Schizoneura?), as soon as the aerial colonies of the aphis are established on the apple.

Good-sized larvæ were collected August 3, 16 and September 1. Pupæ were formed August 14, 21 and 24, the adults emerging from 11 to 13 days later.

So rapacious are these larvæ that they practically exterminated the Woolly Apple Aphis about Orono by the first half of September. Dr. Edith M. Patch tells me this is the usual experience year after year.

Walsh and Riley (48, 49, 57) have described and figured a species of this genus, which was found feeding on *Schizoneura lanigera* and *Phylloxera vastatrix*, under the name of "The Root-louse Syrphus-fly (*Pipiza radicum* n. sp.)." Osten Sacken (38, p. 120) listed this species as a synonym of *femoralis* as did also Williston (62, p. 26) with a query. The type specimen appears to be lost but Coquillet (11) concludes from a comparison of the original description with the type of *Pipiza pistica* Williston that they are the same, hence the latter a synonym of *radicum*, and consequently that "the root-louse Syrphus-fly" should be known as *Pipiza radicum* Walsh and Riley, being distinct from *femoralis* Loew.

Williston (62, p. 29) at the same time that he described *Pipiza pistica* described another species, *P. pisticoides*, from a single female from Mount Washington, as follows:

"Resembles *P. pistica* very much but seems evidently different. The third joint of the antennæ is orbicular, as broad as long; the pile throughout is shorter on the abdomen scarcely discernible; the size is also distinctly smaller."

Certain specimens collected in Ohio and one specimen, reared from an overwintering puparium among *Schizoneura americana*

on Elm agree with Williston's description of (*pistica*=) *radicum*. In these species the third joint measures, — maximum width, .32 mm. by maximum length about .5 mm., the ratio being roughly 1 :1.6.

However, the specimens reared in Maine are much less evidently pilose, and have the third antennal joint noticeably smaller and more elongate; measuring, maximum width, .25 mm., maximum length .42 mm., the ratio being roughly 1 :1.7.

Another difference between the above groups of specimens (which may or may not hold true for a larger series) is in the length of the posterior, or medio-cubital, cross-vein at the outer end of the discal cell. In the Maine specimens (*pisticoides*) this vein is about .45 mm. long, one-fourth shorter than in the Ohio specimens (*radicum*) where it measures nearly .6 mm.

The above specimens are therefore referred to *Pipiza pisticoides*.

Larva. (Fig 29-1) Dimensions, average of eight, length, 6.75 mm., maximum width, 2.3 mm., height 1.8 mm. A wrinkly, moderately spiny, pale-yellowish or flesh-colored larva, usually much obscured by the woolly excrescence of the aphids among which it is found. Segments 5 to 11 inclusive of nearly equal width, the fourth and twelfth a little more than half as wide. The remaining anterior segments retracted except when the larva is active, then strongly accuminate to the terminal mouth-parts. Mouth-parts of the aphidophagous type with slender accessory thorns and a pair of prominent, short and heavy lateral mouth-hooks. The anterior larval spiracles slender, inconspicuous.

Each segment with one prominent, and two less prominent, transverse wrinkles, the latter sometimes sub-divided. The produced edges of the segments form two, zig-zag, lateral carinæ one above the other, composed chiefly of the fleshy, conical elevations which bear the dorso-lateral and lateral segmental spines. The entire dorsum covered with minute, close-set pale integumental spines, .015 to .03 mm. long, with broad bases and acute tips. The segmental spines likewise pale, about .1 to .15 mm. long, of two sub-equal parts, the terminal part slender, accuminate, the basal part more than twice as broad.

The posterior respiratory process with a moderate constriction about mid-length; the basal half sub-conical fleshy and papillose, the distal half polished sub-cylindrical, a little flattened dorso-ventrad, at the tip evidently of two tubes fused mesad. The entire process is elevated to a length of about .5 or .6 mm., the polished distal part measuring about .25 mm. in length; maximum width about .25 mm., maximum heigth about .15 mm. The spiracular slits prominent, usually raised on radiating

carinæ. Length of median spiracle about .065 mm., its width about .015 mm. The two stigmal plates separated by a median incision. The circular plates or "buttons" prominent, situated a little dorsad, .035 to .04 mm. in diameter, their inner margins separated by about half their diameter. The inter-spiracular ornamentation consists of four pairs of prominent slender bristles or hairs (Fig. 29-*2*) about .04 to .05 mm. long, a pair dorsad and ventrad of the circular plate, respectively, and one in each of the other interspiracular spaces.

Puparium. (Fig. 29-*3*). Length about 4.75 mm., height about 2 mm., width 2.25 mm. to 2.4 mm. Ventral line strongly concave, the dorsal line moderately elevated, producing almost a semi-circular curve from mouth-parts dorsally around to the posterior respiratory process. Greatest depth and width about the anterior third, tapering moderately on each side to within one millimeter of the posterior respiratory process, thence rapidly to that organ, which occupies a terminal position. Nearly circular in outline as seen from in front, slightly flattened ventrally. Color testaceous brown. Segmental and integumental spines not visible to the naked eye, but giving the puparium a spinulose appearance when somewhat magnified. Other characteristics as in the larva.

Adult. (Fig. 29-*4*). Uniformly black, about 6 mm. long. Antennæ black above, lower half of first and second joints and third joint on basal half of lower side yellow; the distal half and upper side all black. Arista as long as second and third joints together. Front black pilose, a few white hairs across the middle. At each side midway between ocelli and base of antennæ a white pollinose spot. A similar, narrow, elongate stripe of the same pollen on upper part of facial orbits. Face with rather sparse white pile, the eyes and posterior orbits short, white pilose. Thorax and abdomen shining metallic black, finely rugulosopunctate, with very fine short white pile. Legs black with white pile, the following parts yellow; tips of all the femora, the broad base and narrow tip of the four front tibiæ, the narrow base of hind tibiæ and basal joints of the four front tarsi.

Melanostoma mellinum Linné.

One of the most common species throughout North America and in Europe. Of their abundance Schiner (Fauna Austr. i. 291) says (translating freely):

"I have brought in thousands from all possible situations. They are found on every trip and finally tire the poor dipterologist because, while always apparently new, they nevertheless prove, upon closer examination to be nothing but varieties of the same variable species."

Verrall (55, p. 311) writes: "The larvæ of this species are believed to be aphidophagous as they have been bred from *Aphides* on *Chrysanthemum leucanthemum,* but M. A. Giard in Bul. Soc. Ent. France, 1896, p. 234, traced and bred many larvæ which occurred on the umbels of *Daucus carota* (on plants which bore no *aphides*) and which lived

on the bodies of *Musca domestica* and *Chortophila pusilla;* the larvæ attacked these flies at the junction of the neck with the thorax and held on for one or two days before pupating."

On July 24, 1915, I found in a field of oats and wild mustard on the Station farm, many females of this species, their abdomens greatly distended with eggs. They seemed to be feeding on the blossoms of the mustard and no signs of oviposition were found. No aphids could be found on these plants. The ova of the flies were plainly visible through the thin, distended and transparent abdominal sterna and pleura, especially of the posterior half of the abdomen. Only a single male was taken and no others seen. Whether this indicates a relative scarcity of males or simply that the gravid females were more easily taken I am unable to say,—propably the former.

Twelve females were placed in jars with the single (available) male. Two days later July 26, 7 A. M., a large number of eggs had been deposited on the sides of the jar and on grass enclosed; probably having been laid during the night. July 28 by 8 A. M., the eggs were hatching, the duration in the egg stage having been between two and two and a half days. Not being certain of the larval habits, I placed the young in a variety of situations and offered them a variety of substances for food. The only noticeable result was the decided preference shown by the larvæ for very moist situations. From the variety of aphids offered them they seemed to show a preference for *Aphis cornifoliae* from *Cornus* although no larvæ were found among this species in the field.

The larvæ fed in captivity developed rapidly and began pupating August 14.

The following are the dates of pupation and subsequent emergence of adults from the eggs laid July 26.

Pupated	August	14	Parasite	emerged	August	26
"	"	16	♂	"	"	26
"	"	17	♀	"	"	23
"	"	20	♀	"	"	27
"	"	20	♀	"	"	30
"	"	23	♀	"	Sept.	3
"	"	26		"	"	4

Again on August 12 a female in captivity deposited a number of eggs. They were placed quite rapidly at intervals of

about a minute. The following is the rate at which ten successive eggs were laid: 48 sec., 3 min., 2 min., 3 min., 4 min., 1 min. and 20 sec., 1 min., 1 min., 1 min., 1 min.

The above eggs had practically all hatched over night previous to 8 A. M., August 16; the duration in the egg stage having been about 4 days.

On August 7 a number of females were found hovering about among a very dense growth of rape on the Station farm. Careful examination revealed an abundance of eggs, which later proved to be this species, deposited on the under side of the lower leaves near the ground where it was constantly wet or damp. The eggs were ranked quite closely side by side in groups of from 2 to 8, more commonly 4 or 5 (the sides of the eggs touching each other). These eggs hatched August 11. The larvæ were apparently half-grown by August 23, and began pupating August 31 to September 4.

At the same time (August 7) a large number of larvæ of all sizes, and pupæ in all stages of development, were found on the under side of the leaves among the rape. The larvæ apparently sought out the moist places near the ground. These plants were infested with *Myzus persicae* but the aphids present at this time were fewer in numbers than the predaceous larvæ. It seems to me likely that here is a case where an infestation of aphids, which must have been severe to mature so many hundreds of larvæ, had been all but exterminated by the predaceous larvæ. This opinion gains confirmation from the fact that many of the pupæ present were undersized and somewhat misshapen, such as often results from starving larvæ. The larvæ collected were placed in all conceivable situations to see if possibly they might feed on some other food; but all foods were refused except aphids. They showed a preference for *Myzus persicae* and *Aphis cornifoliae* from *Cornus*. Fed on these aphids in captivity the larvæ pupated between August 7 and 11, and adults or parasites emerged August 14 to 18.

Of larvæ collected August 16 two pupated August 24, one emerging as adult August 28 the other August 31; another pupated September 4 and emerged as adult September 9.

Egg. (Fig. 30-*1, 2, 3*). Of the usual Syrphid shape, sub-cylindrical, a little broader and more rounded at one end, narrower and truncated at the micropylar end. The dimensions of 56 eggs from several different

females were as follows: The length ranged from .8 mm. to 1.057 mm., with an average of .96 mm.; the maximum width ranged from .315 mm. to .4 mm. with an average of .36 mm. Figure 30-*1* and *2* is from camera-lucida drawings of three masses of eggs as found in nature. The sculpturing on the egg-shell (Fig. 30-*3*) consists of irregularly-shaped elevations 5 to 10 times as long as broad and separated by depressed areas several times their width. Each elevation has around its border a varying number (commonly about a dozen) of short, irregularly-sized and unsymmetrically-placed, lateral extensions. Forty-five to fifty of these elevations occur end to end the length of the egg, and eighty to ninety side by side around its circumference. Color: chalk white.

Larva. (Fig. 30-*4, 5, 6*). Length when well extended 8 to 9 mm., width about 2.5 mm. Color saturate lettuce-green, a little more yellowish mediad. One of the most characteristic things about this species is the unusual transparency of the integument and the unusual plainness with which much of the viscera shows through the body wall. Integument finely papillose but without vestiture. The segmental spines consist of a fleshy, sub-conical base surmounted by a slender blunt peg of about equal height, the whole small, light-colored, entirely inconspicuous. The greenish color is usually entirely obscured mediad, from a little in front of the middle, backward, by a black mass of visceral matter. This mass extends nearly half the total width but is overlaid on each side by several longitudinal chains of whitish, adipose cells, which extend throughout about the posterior two-thirds of the body. Between the latter is a longitudinal, pulsating heart-line,—entirely dull black except where it is crossed by folds of the intestine. Laterad of the several whitish chains of cells, and to some extent among them, the black again appears. Near the mid-dorsal line in the second fourth of the body on each side is a single chain of black polygonal cells. The lateral third of the body and all of the anterior end entirely greenish, except for a slender white line on each side formed by the longitudinal tracheal trunks, which run from anterior to posterior spiracles. These trunks give off fine superficial branches mediad at each segment.

The transverse folds of the integument and the division into somites are inconspicuous, as are also the antennæ and anterior spiracles. The latter are a little more than usually elongate and conical. The double A-shaped mouth-parts may be seen through the segments at the anterior end or terminally when extended. There is a pair of heavy, black, lateral mouth-hooks. Just in front of the posterior respiratory organ, between the two tracheal trunks, is a mass of very finely-divided white filaments (tracheæ?) especially noticeable when the larval skin is moist.

The posterior respiratory process is about .3 mm. broad at the end, about .17 mm. in depth, and elevated above the surface of the last segment only to a length of about .1 mm. or .12 mm. Circular plate evident; the three pairs of spiracles unusually short, less than twice as long as broad,—.05 mm. long by about .03 mm. wide. The interspiracular ornamentation consists only of four pairs of short, rounded nodules. A moderate emargination between the two stigmal plates.

Superficially the larva resembles most closely those of *Sphaerophoria cylindrica* or *Allograpta obliqua* (*q. v.*) being about the same size and similar in color and structure. However, besides the greater transparency of the integument in this species, *Melanostoma mellinum* can be very certainly separated from the other two species; *first,* by the shorter, more nearly sessile, posterior respiratory organ which is less than half as long as broad, whereas in *Sphaerophoria cylindrica* and *Allograpta obliqua* it is considerably longer than broad; *secondly,* by the greater length of the individual spiracles on the posterior respiratory process in *S. cylindrica* and *A. obliqua.* In *M. mellinum* the slit-like spiracles are less than twice as long as broad, while in the other two species they are each at least three times as long as broad.

Puparium. (Fig. 30-*7, 8, 9*). Length 6 to 7 mm., width about 2 mm. to 2.25 mm., height about 1.7 mm. to 2 mm. Usually broadest and highest about the anterior fourth. Very moderately elevated, the posterior half of the body being especially attenuated, the dorsal line descending very gradually to the posterior respiratory process. Color dilutely greenish or yellowish. The larval skin retains its great transparency in the puparium so that the developing imago is quite plainly discernible. On this account this is one of the very few puparia of the aphidophagous type on which anterior pupal spiracles or cornua can be detected. These (Fig. 30-*7 A*) are located near the cephalo-dorsal corner of the puparium and appear as mere specks even at moderate magnification, being about .025 mm. across. Hence they would be entirely obscure (as they are in most related species) if it were not that the relatively large tracheal trunks leading from them to the prothorax of the nymph can be discerned through the puparium.

When highly magnified (Fig. 30-*8, 9*) the pupal respiratory cornuum is seen to be a nearly cylindrical elevation, a half longer than broad and the end differentiated into eight denticles, evenly distributed and not contiguous, around the circumference of the apex and extending a short distance down the sides. Each denticle oval in outline, several times as long as broad.

Adult. (Fig. 30-*10, 11, 12, 13*). Length 6 to 7 mm. *A brilliantly shining, metallic black species with bright yellow spots on the abdomen; facial tubercle small; hind metatarsi not thickened*

In the male the frontal triangle a little prominent with a pit in the middle; in the female the frons with a broad shallow transverse depression. Frons and face shining, whitish-dusted on the sides. Antennæ yellow to black, usually brownish on upper half, yellowish below except at tip of third segment, arista very briefly and short pubescent, nearly bare, yellow at the base. Abdomen *in the male* (Fig. 30-*13*) about four times as long as broad, dull black with three pairs of yellow spots; the

first pair on the middle of the second segment, inner ends rounded; the others at the basal corners of the third and fourth segments, subquadrate, a little longer on the median side extending broadly over the margins. *In the female* the abdomen (Fig. 30-*12*) is shorter and oval, shining, with four pairs of orange spots the first pair small, isolated, near the middle of the segment; the third and fourth pairs subtriangular, touching the anterior margins, the posterior point rounded, the spots (either isolated or) narrowly reaching the side margins at the extreme base of the segment; the fifth segment with a pair of small slender basal spots. Legs variable, yellow to black.

Sphaerophoria cylindrica Say.

(See also 33, p. 538 and 35, p. 59).

This is an exceedingly common, and one of the most valuable aphidophagous species about Orono, and probably throughout North America. It has a variety of species of prey and may be expected in almost any colony of aphids.

Partly grown larvæ were taken June 17 from among *Aphis viburnicola* on *Viburnum opulus;* were full grown by June 28, in puparium June 30 and emerged as adults July 7. Other larvæ collected from the same source June 25, pupated July 2 and emerged July 9.

On July 7 four larvæ and one pupa were collected on Rose among *Macrosiphum solanifolii,* but all were parasitized.

A small larva collected July 14 among *Aphis rumicis* on *Evonymus alatus* was full grown and pupated July 24, emerging July 30. On the same date larvæ were collected from *Myzus cerasi* on wild cherry and a pupa from *Phorodon humuli* on plum. The former pupated July 17 and all emerged July 22.

On July 16 a pair were taken *in coitu* about blossoming turnip at 10 A. M. By 3 P. M. of the same day the female was ovipositing which continued until the death of the female on July 19. By the latter date many of the eggs were hatching.

July 26 two parasitized larvæ were taken from *Aphis cerasifolii* on *Prunus virginiana* and July 28 two puparia from the same host, the flies emerging August 3 and 6. July 31 a puparium was taken from flowering currant, the adult emerging August 7. And on the latter date larvæ and pupæ were found in all stages of development on rape, sparingly infested with *Myzus persicae.* Adults from these puparia emerged August 14.

Egg. Of the usual shape, less pointed anteriorly than that of *Allograpta obliqua* (Fig. 31-*61*, *62*). Length of twelve eggs measured, ranged from .91 mm. to 1.015 mm., with an average of .958 mm.; the maximum diameter from .32 mm. to .37 mm., the average .34 mm. Color, chalk white, sculpturing similar to that of *A. obliqua* (Fig. 31-*63*) but the elevated bodies a little shorter and broader than in that species, about two or three times as long as broad; distance between bodies about half their width; number of arms around each, 12 to 20; rather short, not much branched, many ending at half the distance across the intervening space. Number of bodies around the egg at the middle about 50; number the length of it about 30.

Duration in the egg stage about two or three days. The eggs are laid singly at short, varying intervals of time. In captivity the female always moved about after each egg was laid before depositing another. The actual process of placing the egg is speedily accomplished, the egg slipping out of the much extended ovipositor very quickly. The end is touched to a leaf where the "glue" fastens it and the ovipositor is then quickly drawn away from it, retracted, and the fly crawls away some little distance when the process is repeated. In the field the insect *flies* about from place to place, occasionally resting briefly on the under side of a leaf for the deposition of an egg. This habit of scattering the eggs of aphidophagous species is of value in preventing the too great congregation of larvæ and consequent scarcity of food. In captivity the insect frequently rested and manipulated the extended ovipositor with her hind legs, rubbing the metatarsi over it. Whether this is a natural habit or induced by some artificial condition (as, possibly, contact with the sugar solution supplied as food) I do not know. The female laid eggs at the following rate: 4 minutes, $7\frac{1}{2}$ minutes, $\frac{1}{2}$ minute, $\frac{3}{4}$ minute, $2\frac{1}{4}$ minutes. About 60 eggs were laid by a female taken *in coitu* and kept confined.

Larva. (Fig. 31-*76*). Length 9 to 10 mm., height 1.25 mm., width 2.25 mm. Elongate oval, tapering at anterior end, somewhat truncate except for respiratory appendage at posterior end, depressed. Outline irregular, dorsal integument much wrinkled transversely, and with lateral, longitudinal carinæ. Color pea-green with two, narrow, longitudinal, white stripes, laterad of and paralleling the rather conspicuous dark heart-line. The stripes attenuated and confluent a little before the anterior end, not reaching the respiratory appendage posteriorly. Respiratory appendage brownish black at the tip. The skin papillose, bare except for the usual segmental bristles which are here short, light-colored and inconspicuous. There are a number of poorly defined proleg-like projections of the body on the ventral side. The mouth-parts

(Fig. 31-77) consist of three pairs of hooklets in addition to the pair of jaws. One pair of hooklets is short and heavy, triangular, lateral in position (Fig. 31-77 *d*), the other two pairs, situated close beside the jaws (*c*), are slender, elongate, slightly curved. The jaws (*b*) are of the usual type but U-shaped rather than V-shaped, the shoulders rather prominent, with a median, terminal, pointed projection.

The antennæ (Fig. 31-77, *a*), and anterior spiracles are rather well elevated. The latter on a fleshy base with a prominent constriction beyond the middle showing at the apex a small number of rounded teeth or lobes about three larger and three smaller ones, (Figs. 31-74, 75).

The shape, color and general appearance is very similar to the larva of *Allograpta obliqua*.

The two species can, however, be very certainly and definitely separated on the basis of the posterior respiratory appendages. These are about the same length and other dimensions; the difference lies in the distal end. As described in *Allograpta obliqua* the two tubes are slightly divergent at the tip making them broader here than at mid-length, and bear between each two spiracles a short, but readily visible, spur-like elevation continued as a slight ridge down the side of the tube. In *Sphaerophoria cylindrica* the end of the tube is very nicely and evenly rounded off; the spiracles very slightly elevated; the two tubes slightly emarginate but not at all divergent, and all trace of inter-spiracular spines or projections lacking. The posterior respiratory appendage .35 to .415 mm. long, .31 to .335 mm. wide, .15 to .175 mm. high. The median spiracle about .065 mm. long. The circular plates .035 to .04 mm. in diameter, their inner margins about .065 mm. apart. With the aid of a good hand-lens one can always separate these two species at a glance when the characters have once been fixed in mind. (See Figs. 31-72 and 73 and compare Fig. 31-66 and 68).

Larvæ were taken almost continuously from mid-June to mid-August and probably occurred before and after these dates. The duration in the larval stage appears to be about two weeks.

Puparium (Fig. 31-78). Length, exclusive of respiratory process, about 5.3 mm., height about 2 mm., width about 2 mm. In general shape, color and appearance so similar to *A. obliqua* as scarcely to permit of separate description. The puparium is generally less strongly elevated on the posterior part. The characters of the posterior respiratory appendage, however, remain as in the larva and will always serve to distinguish these two species.

Puparia were taken from June 30 to August 7. In all cases these were found glued by the posterior part of the venter to the leaves of the host plant. The duration in the pupa stage ranged from 5 to 9 days.

Adult (Fig. 31-71). The following description adopted from Williston (62, p. 105) applies to the adults reared from the above described larvæ and pupæ. Length 6 to 8 mm. ♂. Face and front light yellow, shining; tubercle somewhat fuscous. Antennæ reddish yellow. Dorsum

of thorax dark greenish olivaceous with a yellow lateral stripe, indistinct or wanting back of the suture. Pleuræ with light yellow spots as shown in Figure 31-*71*. Scutellum sulphur yellow. Abdomen slender, second segment with a broad yellow cross-band in the middle, and a brown or black band in front and behind, not reaching the lateral margin. Remaining abdominal segments variable, third with a broader yellow band and more narrowly brown or blackish in front and behind. Hypopygium wholly reddish-yellow, globose, with a tuft of pile below in front. Legs yellow including the coxæ.

♀. Front shining black, yellow on the sides below; yellow lateral stripes of thorax extending only to the suture. Abdomen moderately broad, shining black, with the extreme lateral margins continuously yellow and a moderately arcuate, entire, yellow band, reaching the yellow on the sides, on each of the segments from two to four inclusive. These bands cover about one-third the length of the segment. Fifth segment with a similar but slenderer yellow band interrupted in the middle. Sixth segment yellow with some black on the disk. In other respects as in the male.

Allograpta obliqua Say.

(See also 33, p. 533 and 35, p. 58.)

This species which ranges throughout much of this country and is often common, was very rare about Orono during 1915, being represented in the collections by a single male taken about blossoming cabbage, July 29. The immature stages were not encountered. However, on account of its close resemblance to *Sphaerophoria cylindrica* and *Melanostoma mellinum*, and the certainty that it does occur here, the following brief descriptions are included from the author's Ohio report (33).

Egg. (Fig 31-*61*, *62*, *63*). Elongate oval in outline, narrowing to the roundly-pointed anterior end and the truncate micropylar end. Length about .8 mm., diameter about .3 mm. Color chalk white, with the usual microscopic sculpturing (Fig. 31-*63*). The main bodies of the elevations are broader than in *Syrphus americanus*, three or four times as long as broad; sub-oval, the arms thicker and shorter than in *S. americanus*, usually about fifteen around each body. The depressed space between the bodies about two-thirds as wide as the body. About 28 of these elevated bodies the length of the egg; about 55 around it at the middle.

Larva. (Fig. 31-*65*, *66*, *67*, *68*). When just hatched (Fig. 31-*65*) the larvæ have a length of 1.2 mm., width .25 mm. They are irregular in outline, nearly cylindrical, broadest near the middle; feeble and inactive. Color whitish, with a yellowish or greenish tinge. The usual small, fleshy, conical, segmental elevations are present, twelve to each segment, but no bristles were discernible on them. The posterior breathing

appendages are rather prominent, longer than in a young larva of *S. americanus,* and light in color like the rest of the body. Their tips are, at first, rather remote from each other though with subsequent growth and their greater elevation above the general body surface they become contiguous. The two longitudinal fat bodies are discernible as a white line on each side of the dorsal blood-vessel which is more prominent in the posterior half of the body. The skin is faintly wrinkled transversely.

From this condition there seems to be a gradual growth until the larva, when full-grown has reached a length of about 8 mm., width 2 mm., height 1.25 mm. It may then be described as follows: Shape elongate oval, but much more pointed at the anterior end when extended The outline is somewhat irregular due to folding and wrinkling of the skin. The posterior end is rounding, truncate except for the projections of the posterior breathing organ; (Fig. 31-*66*).

Color green, with two longitudinal white stripes. This color is due to colored visceral bodies which show through the transparent skin. Along the mid-dorsal line for two-thirds the length can be seen the narrow, dark, pulsating blood-vessel. It is irregularly limited at the sides by a narrow mass of greenish, fatty globules changing gradually to whitish. This whitish adipose matter forms the two prominent longitudinal white stripes, .2 or .3 mm. wide and extending to within a few millimeters of either end where they become much attenuated. The rest of the body, except the appendages is green, darker on the sides. The breathing tubes are light brown, black at the tips where the spiracles are located.

The skin is finely papillose when magnified, bare except for the segmental bristles which are light in color, not elongate and not conspicuous. The outer pair of mouth-hooks (Fig. 31-*67, c*) is present. The posterior respiratory appendage is prominent, elongate, about .5 mm. in length, .33 to .4 mm. in breadth and a little less than .2 mm. in height; the two fused tubes diverging slightly at the extreme tip (Fig. 31-*66, c; 68*). The median spiracle .08 to .09 mm. long, about .015 mm. broad, the carina bearing the spiracle about three times as long as broad. The circular plates about .05 mm. in diameter, their inner margins about .08 mm. apart. There is a short, but distinct, spur-like nodule on each interspiracular space, which is continued down the side of the tube as a more or less evident ridge.

Puparium (Fig. 31-*69, 70*). Dimensions, average of eight: Length about 5.25 mm., maximum breadth 2.5 mm., maximum height 2.3 mm. This neglects the breathing tubes at the posterior end of the body which may project .5 mm. farther posteriorly or be directed more dorsally.

The puparium is broadest and deepest in front of the middle, the anterior end bulbous; strongly and evenly depressed and compressed to the posterior end, the posterior elevation very gradual. (See Fig. 31-*69* and *70*).

The color in this stage changes very decidedly during the development of the nymph within the translucent puparium. The color being due almost entirely to the inclosed matter is consequently at first the color of the larva—light pea-green with a brownish remnant of the dorsal blood vessel and, at the sides of this, the two whitish lines. The flattened posterior end of the puparium, including the breathing tubes, however, is light testaceous brown, the tips about the spiracles black. Midway on the length of the breathing appendages is a dark brown ring.

As the pupa develops within, the color changes, gradually losing all trace of the green and assuming more and more the colors of the adult. The first thing to be noticed is the reddish brown color of the eyes replacing the green in the anterior third of the pupa. Later the black and yellow abdominal markings become apparent.

The puparium is smooth, bare; the segmental spines inconspicuous. The breathing tubes as in the larva, prominent sub-cylindrical. The wrinkles of the skin often remain rather prominent.

Adult. (Fig. 31-64). Description after Williston (62, p. 96). "♂ ♀. Length, 6 to 7 mm. Face yellow, often with a bluish reflection, slightly brownish on the tubercle. Frontal triangle yellow; front in the female shining black on the vertex, continued as a broad stripe (broadest below) to the antennæ; on the sides the yellow of the face continues up along the eyes nearly to the ocelli. Antennæ reddish-brown, blackish on the upper part of the third joint. Thorax deep shining green, on the sides with a yellow stripe reaching from the humeri to the suture, where it is sharply truncate; post-alar callosity also yellow. Scutellum wholly light yellow, faintly reddish on the disk; pile black. Abdomen black or brown; first segment, except a slender transverse spot on each side behind, yellow; second segment with a slender yellow anterior fascia, and a broader one in the middle, about a third of the width of the segment; straight and but slightly widened at the sides; third segment with a broad arcuate band, not quite touching the posterior angles on the sides; fourth segment with two slender parallel stripes, leaving a slender black stripe between them, on each side a broader, oblique, oval spot, touching, or narrowly separated from the anterior end of the yellow longitudinal stripe, and reaching to the posterior angles; fifth segment similar, but the side spots less oblique. Legs light yellow; last three joints of all the tarsi, the hind tibiæ, except the base and a middle ring, and a ring on outer part of hind femora, brownish. Wings hyaline, veins black."

Syrphus americanus Wiedemann.

(See also 32, p. 477 and 35, p. 55.)

This American Syrphus-fly apparently ranges throughout North America and ranks along with *Sphaerophoria cylindrica* as one of our most valuable predaceous forms. The larvæ have

been found preying on the following aphids in this State: *Aphis pomi* on apple; *Pterocomma flocculosa* on willow; *Symdobius oblongus* on white birch; *Aphis spiraecola* on spiraea; *Schizoneura lanigera* on apple and *Microparsus variabilis* and *Chaitophorus viminalis*. The larvæ were common during late July and early August. Pupæ were noted July 29 to August 2, the adults emerging ten to eleven days later. The office records show that larvæ, pupæ and adults occur in the State almost continuously from mid-June to mid-September at least.

Egg. (Fig. 32-41, 42, 43). Elongate-ovate in outline, sub-cylindrical, narrower and truncate at micropylar end, nicely rounded off at the opposite end, broadest in front of the middle (Fig. 32-42); somewhat flattened to the surface to which it is attached, slightly humped or rounded up above (Fig. 32-41). Length about 0.9 mm., diameter at middle about 0.3 mm. Color chalk white.

The sculpturing of the chorion consists of microscopic projections of the surface arranged in lines running longitudinally-obliquely around the egg. Each projection consists of a long, slender, irregular body (seven or eight times as long as broad) sometimes bent, with about twelve to twenty slender arms reaching out in all directions from it. The space between these bodies is roughly a half wider than the body itself. Into these spaces the arms project, most of them meeting similar projections from the same or another body, many branching so as to form a delicate network of slender white arms between the larger bodies. Figure 32-43 is a fair representation of a small part of the surface of the egg-shell, highly magnified. The projections are chalk white, the depressions between them shaded, appearing grayish or yellowish. The bodies are of such a size that one may count about 25 the length of the egg and about 50 around it, transversely.

Larva. (Fig 32-45, 46, 47, 48, 49, 50). Just after hatching (Fig. 32-45), length 1.2 mm., width .2 mm. to .3 mm. Shape sub-cylindrical, broadest at the posterior end, narrowing evenly to the anterior end, not enlarged in the middle. Color light yellow or with a greenish tinge. Body surface wrinkled, the sides irregular. *Segmental spines on the fourth to eleventh segments, inclusive, and the dorso-lateral ones on the third segment, very long, slender, black; giving the young larva a very hairy appearance, so far as I know characteristic of this species.* The posterior breathing appendages short, slightly divergent (Fig. 32-45, *a*). No integumental vestiture. Dorsal blood-vessel faintly discernible in the posterior half of the body. During subsequent growth these slender segmental hairs are replaced by shorter, stouter, more spine-like bristles; the posterior breathing appendages are slightly elevated becoming united on the median line; and minute black spines appear all over the dorsal surface of the body.

Mature larva: Length about 11 mm., width about 2.5 mm., height about 2 mm. (Fig. 32-*46*). Compared with many other aphidophagous larvæ this species is noticeably elongate, slender, with more nearly parallel sides. Segments 6 to 11 of nearly equal width, the twelfth narrower and much depressed. Anterior to segment six the body tapers evenly to the mouth-parts when extended, or rounds off at segment four when at rest, with the head segments retracted. Body-wall prominently wrinkled and with the usual two longitudinal carinæ at each side. General color yellowish, or salmon-brown, marked with black and white. The whitish markings consist of a transverse, rectangular bar on each segment, from six to eleven, and a narrow line along each side of the larva in the dorsal lateral carina. Interrupted by the transverse white bars at each segment, is the mid-dorsal heart-line, consisting of six elongate, wedge-shaped, black marks, broadly margined with brown. Laterad of the brown are other prominent black blotches extending obliquely outward and back to the whitish lateral carinæ. The anterior two or three segments unmarked with black or brown, light greenish-yellow in color. The amount of brown color variable, frequently covering the entire dorsum except the heart-line in segments ten to twelve.

The entire dorsum of the larva covered with short, close-set, black, integumental spines. The segmental hairs larger but light in color and not conspicuous, situated on slight elevations.

The posterior breathing appendages on the dorsum of the last segment, (Fig. 32-*46, c; 49;* and *50*) are short (0.2 to 0.25 mm. long) and nearly twice as broad (0.4 to 0.5 mm.); divergent for half their length; the dorsal spiracular spines (Fig. 32-*49* and *50, a*) moderately long, sharply conical, with a very small lateral sub-basal spur. The six elongate spiracles (*b*) are irregularly and considerably curved, about 0.2 to 0.25 mm. long, the median one on each side nearer to the ventral than to the dorsal one.

The anterior prothoracic spiracles on the third segment (Fig. 32-*46, b; 47, a*) are small,, subcrescent shaped, the lip of the spiracle marked by nine rounded, tooth-like lobes, (Fig. 32-*48*).

The mouth-parts (Fig. 32-*47, c, d, e*) consist of the usual pair of beak-like jaws (*c, d*) and three pairs of mouth-hooks (*e*). The jaws are A-shaped, sharp, slightly hooked at the tip, somewhat shorter than usual, the dorsal extending slightly beyond the ventral when apposed. The latter has a ventrally projecting basal spur on each side. The mouth hooklets are unequal in size the outer pair largest; the other two pairs are situated close beside the jaws, the dorsal ones heavier, the ventral pair small, slender.

Puparium. (Fig. 32-*51, 52, 53, 54, 55, 56*). Dimensions, average of 15: Length 6.5 mm., height 2.5 mm., width 2.6 mm. The head segments of the larva are retracted ventrally so that segments 3 to 5 lie at the anterior pole and the tip of the mouth-parts (terminal in the larva) are about 0.5 mm., back on the ventral side. The wrinkling of

the skin, characteristic of the larva is largely lost, due to the inflation. The vestiture remains as in the larva, the segmental spines inconspicuous, but the exposed parts of the wrinkles of the larva, densely covered with very small, short, sharp, black spines. Sometimes this gives a rather prominent transverse banding of black where the spines are thickest.

The posterior three segments are proportionately less inflated than the middle ones. Shape from dorsal aspect ovate with the last segment and its respiratory appendage projecting; very slightly broadest in front of the middle, nicely rounded out in front. From the side (Fig. 32-56) the anterior and dorsal inflation is evident; the puparium is not strongly elevated posteriorly, being convexly depressed gradually from about the middle. From in front the puparium appears nearly circular in outline, very slightly flattened ventrally.

Color of the puparium, empty: pale brown, transparent; with pupa enclosed: variable, darker brown, strongly tinted with salmon. A day or two before emergence the prominent colors of the adult become plainly visible.

Adult. (Fig. 32-44). Description after Wiedemann (61) and Osten Sacken (39, p. 145).

♂. ♀. Length 8 to 10 mm. Female. Face yellow, in certain positions with a pearly luster, *with a brown stripe* in the middle, which begins at the oral margin but does not reach the antennæ; the latter brownish-black, reddish on the underside of the third joint. Cheeks blackish, *but separated from the mouth by a narrow yellow border,* which on the underside of the mouth completely cuts off connection between the black color on both sides. Front brownish bronze color, powdered with yellow on each side. Immediately above each antenna there is a brownish spot sometimes continued above into an indefinite black stripe; vertex metallic bronze or black, eyes bare. Thorax metallic greenish black, unstriped; with scattered luteous pile; on the sides, in front of the base of the wing, yellowish; elsewhere metallic green; scutellum metallic yellow, with a bluish reflection and sparse yellow pile. First abdominal segment metallic blue; the rest of the abdomen black with bright yellow cross-bands. The first abdominal cross-band is not interrupted but co-arctate in the middle; its ends do not touch the margin of the abdomen, but are separated from it by a narrow black border; sometimes a brownish mark in the middle of this band gives it the appearance of being sub-interrupted. The second cross-band is nearly as broad as the black cross-band between it and the next yellow band; it is usually perfectly straight (in some specimens the hind margin is gently sinuate); its ends do not touch the lateral margin of the abdomen; they are cut obliquely, forming a sharp angle anteriorly, and a rounded one posteriorly; the former almost touches the margin of the abdomen. The third band is similar to the second, only its hind margin is more perceptibly arcuated. The posterior margin of the fourth segment has as usual, a narrow yellow border; the fifth likewise,

and two yellow spots at the base besides. Femora yellow; the four anterior ones in some specimens brownish at the extreme base only; the hind pair with a more or less distinct brown ring on the distal half; four anterior tibiæ and tarsi yellow; the hind tibiæ sometimes with a brownish ring, the hind tarsi brownish.

Male (Fig. 32-44). Front yellow, with a more or less distinct brown spot above each antenna; cross-bands on the abdomen broader than in the female, and distinctly broader than the black interval between them; posteriorly, they are often nearly straight, sometimes distinctly arcuate, especially the third band. The yellow spots on the second segment are not coalescent, but separated by a narrow black interval (in some specimens sub-coalescent); the fifth segment is yellow, with a black spot in the middle. The four anterior femora are black at the base; the hind femora are usually black, with a yellow tip; sometimes there is a trace of yellow at the base; hind tibiæ usually with a brown ring in the middle.

Syrphus torvus Osten Sacken.

(See also 30, p. 341 and 35 p. 57.)

Common to abundant throughout June and first half of July; rare during late July and throughout August. Reared from among *Aphis spiraecola* on spiraea and *Phorodon humuli* on plum seedlings. Hundreds of adults were noted about these colonies, feeding on the honey-dew secreted by the aphids. One male in the collection bears the label: "Hibernating puparium under leaves, Houlton, Maine, May 7, '07."

Larva (Fig. 33-*10, 11, 12, 13*). Length, 10 to 12 mm., width 3 to 4 mm., height about 2 mm. Shape sub-cylindrical, tapering rapidly in front to the mouth-parts, slightly narrowed but blunt and emarginate at posterior end; integument raised into numerous transverse folds continued laterally into a distinct longitudinal keel on each side (Fig. 33-*10*). First three body segments small, retractile, gradually thicker; next eight sub-equal; terminal segment flattened, bearing on its dorsal surface the posterior respiratory process (Fig. 33-*10, b; 13*). The spiracles narrow, elongate, nearly straight. The interspiracular ornamentation of slightly elevated, inconspicuous ridges. Circular plate dorso-mediad. Mouth-parts (Fig. 33-*11*) with a prominent pair of lateral mouth-hooks (*c*). Between the second and third segments dorsally is a pair of small brownish anterior spiracles (Fig. 33-*10 a, 11 g*); conical, the semicircular slit guarded by seven rounded teeth (Fig. 33-*12*).

The general color of the larvæ is brown pink. The integument is tough but transparent; naked but very finely papillose. The black mid-dorsal blood-vessel is prominent and in the living active larvæ the blood may be seen pulsating regularly from posterior to anterior end. Laterad of this blood-vessel are two long yellowish bundles of fat,

irregularly outlined, extending practically the full length and varying in width. At the approach to metamorphosis these adipose masses increase in extent sometimes covering nearly the entire dorsum except the blood-vessel. At times also the body fluid invades more or less the fatty bodies appearing as outlying pulsating pockets.

Puparium (Fig. 33-*14, 15*). Length 8 to 8.25 mm., width 3.5 to 4.3 mm., height 3.75 to 4 mm. Testaceous brown, naked, smooth except for slight remains of the transverse wrinkling of the larva. Broadest in front of the middle, nicely rounded in front, descending rapidly at the posterior end to the projecting respiratory process.

Adult (Fig. 33-*9, 16*). Length ♂, ♀, 10 to 12.5 mm. Description, slightly modified after Osten Sacken (39, p. 139).

Female (Fig. 33-*9*): Face and cheeks yellow, a faint grayish spot on the cheeks under the eyes. Front and vertex shining black with black pile; the front on both sides along the eyes with a broad border of yellowish pollen sometimes meeting the similar border of the opposite side. This pollen continues in dilute form down the sides of the face crossing narrowly beneath the antennæ. Eyes pubescent (in many specimens the pubescence is very much rubbed off and very difficult to perceive). Antennæ inserted beneath a double arched ledge of front. The dark color of the front begins immediately above their root forming a blackish brown arch with a projecting angle in the middle. Antennæ dark brown; third antennal joint below and the bare arista sometimes more or less reddish. Face in profile perpendicular beneath the antennæ produced but little below the eyes, slightly concave beneath the antennæ to oblique tubercle, receding below (Fig. 33-*16*). Thorax dull greenish with but little luster; in well preserved specimens with three faint dorsal longitudinal darker stripes, divergent posteriorly; scutellum dull yellowish with a slight bluish reflection. The black pile of scutellum and dorsum of thorax changes to yellow on the sides of the latter where it is also much thicker and longer. Third longitudinal vein nearly straight; anterior cross-vein a third of the way from base to apex of the discal cell; anterior outer angle of first posterior cell acute. Entire sub-costal cell brown; root of wings as far as humeral cross-vein and the costal cell slightly tinged with brown. Legs slender; coxæ and basal third of femora black; on the hind pair the black reaches beyond the middle of the femora; hind tibiæ often with a brownish ring; four anterior tarsi brown the root of the first joint often reddish; hind tarsi dark brown.

Abdomen oval slightly broader than thorax; about twice as long; with three prominent yellow cross-bands, the first interrupted in the middle, all attaining the lateral margins. First segment entirely black; second segment with a yellow elliptical spot about the middle on each side prolonged usually as a narrow neck which reaches forward and touches the margin. Third and fourth segments each with a yellow cross-band on its anterior half, the hind margins of these bands very gently biconvex with a very shallow sinus at the middle; on each side

the cross-bands are attenuated and curved forward so as to reach the anterior margin of the segment. The band on the fourth segment also touches its anterior margin in the middle, while that on the third is more remote from the anterior margin; the black interval between the bands is twice as broad as the bands. The fourth and fifth segments have yellow posterior margins, the fifth usually with two yellow spots on each side at the anterior margin.

Male. "Similar to the female but abdominal cross-bands broader, the biconvexity on their hind side stronger, and the sinus in the middle deeper; the gray spot on the cheeks under the eye often larger, sometimes occupying a considerable portion of the cheek; the brown ring on the hind tibiæ usually expanded so as to reach the tip of the tibiæ. The eyes (contiguous) are more distinctly pubescent, the front is beset with yellow pollen except a narrow black space above the antennæ."

Syrphus nitens Zetterstedt.

Syrphus nitens Ztt. D. Scand. ii. 712 ♀, viii 3137 (Scaeva). Verr. Ent. M. Mag. v. 193; Brit. Fl. Syrph. 377, figs. 295, 296.

Larvæ of this European species, hitherto not recorded for North America, were found on the campus of the University of Maine, July 23 to August 11. Some of them were full grown on the former date, others only about half-grown on the latter date. They were taken among colonies of the Willow Grove Plant-louse (*Pterocomma flocculosa* Weed) on the branches of a willow tree. The aphids were very ravenously devoured. One larva under normal conditions was observed to destroy twenty-one of these large aphids in twenty minutes. Six empty, and one inhabited puparia were found glued to the small branches of the willow on July 26. The adult from this puparium emerged July 31. One of the larvæ collected July 26 pupated July 27 and emerged as adult (♀) August 6. Another pupated August 1 and emerged (♂) August 12. The duration in the pupa stage is therefore about 10 to 12 days.

Besides extending the known distribution of this species, this record is of particular interest because the larvæ are the only ones of the aphidophagous type I have seen in which the spiracles on the posterior respiratory process are not straight but remarkably convoluted (See Fig. 34-3 and 4).

Larva (Fig. 34-1, 2, 3, 4, 5). Length about 15 mm., width about 3 mm., height about 2.5 mm. An unusually slender, elongate species broadest about the eighth segment, but of nearly equal width from segment seven to eleven. The twelfth is nearly a third narrower and somewhat depressed, the posterior end squarish. Anterior to segment

seven the body tapers evenly almost to a point at the mouth-parts, when extended; when at rest the anterior three segments retracted and rounded off at segment four.

In their natural habitat the larvæ were so covered with threads of flocculence from the aphid host as to appear light grayish in color. When this matter is removed the color is yellowish brown, considerably mottled with black. The most conspicuous black markings are due to masses of body fluids showing through the integument; but others are formed by particularly thick areas of the black integumental spines which cover the entire dorsum, but are so minute on the venter that the latter appears bare. The largest of these spines about .04 mm. long. The arrangement of these spots is shown in figure 34-*1*, where only the ones due to integumental spines are shown. There are nine such areas on each somite, three on the middle line and three at each side. The integument is folded transversely, there being about five folds to each somite on the dorsal side. On the ventral side in segments five to eleven, inclusive, are nude elevations suggesting prolegs. The segmental spines are situated on moderate, conical elevations and are about .10 to .15 mm. in length, but light in color. The head segments bear the antennæ and mouth-parts of the kind usual in aphidophagous larvæ. There is a pair of very heavy, black, lateral mouth-hooks. The anterior larval spiracles on the third segment (Fig. 34-*1*) are barely visible to the naked eye. When magnified (Fig. 34-*2*) the surface is found to bear about a dozen, elongate nodules arranged in a semi-circle.

The posterior larval spiracles are unique among aphidophagous larvæ so far observed. They are borne on a very short, double process rather more than usually emarginate distally, about half a millimeter broad, .25 to .33 mm. long and about .33 mm. high. *The slit-like spiracles instead of being nearly straight are remarkably and irregularly sinuate, convoluted or undulated in a very ornamental manner as shown in figure* 34-*3* and *4*. This extensive convolution makes the length unusually great for the spiracles in this type of larva. Between the spiracles the surface of the tube is deeply constricted so that each is situated along the summit of a broadly rounded carina, the most dorsal one the most prominent. The circular plate is only moderately conspicuous, about .055 to .075 mm. in diameter, their inner margins .08 to .1 mm. apart. The inter-spiracular ornamentation consists of small, blunt, rounded knobs sometimes double, entirely inconspicuous.

On several occasions larvæ of this species were noted extruding from the anus on the ventral side of the caudal segment, four finger-like flabellæ similar to those previously described for *Eristalis aeneus* (34, p. 86) but not heretofore noted among aphidophagous larvæ. Buckton (8) considers that these organs have a renal function.

Puparium (Fig. 34-6). The dimensions of ten specimens were as follows: The length ranged from 7.25 to 8 mm., with an average of 7.6 mm.; the width 3.5 to 4 mm., the average 3.75 mm.; the height 3.6 to 4 mm., the average 3.85 mm. The puparium bulbous in front, a little broader than high. The ventral line usually quite concave; the dorsal line well elevated, attaining its greatest height about mid-length. The greatest width about the anterior third, but diminishing very little either in height or width until within about 2 mm. of the posterior end; thence quite rapidly to the last segment which is commonly about one millimeter wide, half a millimeter high, and a millimeter long, uninflated. A prominent mid-dorsal carina, widening out anteriorly extends forward from the posterior respiratory process. The latter structure retains its larval characteristics. The color of the puparium is grayish-brown, with a mid-dorsal, broken, blackish line and an oblique lateral black stripe on the side of each segment due to the integumental spines. The segmental spines are easily detected, but remain inconspicuous because of their fineness and pale color.

Adult (Fig. 34-7). I reproduce Verrall's description of this species in full (55, p. 377), and append some brief notes on the Maine specimens.

"Eyes bare; abdomen ovate, with undulated entire yellow bands which scarcely reach the side-margins; thorax shining; antennæ considerably luteous but darkened above; anterior tarsi mainly yellowish."

"♂. Resembling *S. nitidicollis* but quite distinct; it is broader and flatter both on the thorax and abdomen. Face more blackish about the mouth-edge, until in dark specimens the whole mouth-edge, the jowls, and a middle facial line extending above the central knob are black; on the other hand the black may be restricted in a very pale specimen to a narrow mouth-edge and all the jowls; the pubescence on the face is usually more black, and the pubescence behind the eyes is deep orange instead of whitish as in *S. nitidicollis*. Frons almost always with blackish spots or lunules above the antennæ, but otherwise all yellow or orange, as is the face even up to the extreme top angle instead of being, as in *S. nitidicollis*, blackish grey on the upper part. Antennæ much darker than in *S. nitidicollis*, as they are at least darkened above the third joint, and usually have the whole of the upper part and end of third joint blackish or brownish as well as the upper part of the second joint, or occasionally the antennæ are altogether brownish with only obscure orange spaces beneath the joints; the third joint is distinctly longer than in *S. nitidicollis*, being on the inside much longer than deep after the end of the second joint; arista shorter and inserted farther from the base, with its basal joints more distinct, and after the basal joints more luteous and with a rather shorter thickened portion."

"Thorax brightly shining blue-black with deep orange pubescence. Scutellum with mostly black pubescence."

"Abdomen with more isolated and much more undulating bands, especially as regards the fore-margins of the bands on the third and fourth segments; the spots on the second segment are either isolated or only reach the side-margins at the upper corners, while the bands on the third and fourth segments do not quite reach the side margins and are beautifully undulated especially on the fore-margin; the hind margins of the fourth and fifth segments are less broadly orange; apparently the belly also gives a good distinction as *S. nitens* has isolated central black spots on the second, third, and fourth segments, while *S. nitidicollis* has only the hind margins of the third and fourth segments black; a very important character occurs in the marginal pubescence, which is all black after the basal corners, proving that normally the abdominal yellow bands do not reach the side margins and thereby thoroughly distinguishing it from *S. nitidicollis*."

"Legs quite distinct, as the basal two-fifths of the anterior femora and the basal four-fifths of the hind femora are black; the anterior tarsi have the three middle joints darkened, while the hind tarsi are usually more blackish. Pubescence behind the anterior femora almost all black."

"Wings less orange hued, the whole wing and especially the front part being more smoky."

"♀. Similar to the male, but also differing from *S. nitidicollis* by the undulating abdominal bands, darker antennæ, and flatter more ovate shape. Vertex brilliant purple, which is extended forwards down the middle of the frons for a short distance, which is more obvious when viewed from in front but which leaves the front half of the frons much more yellowish than in *S. nitidicollis;* the dark spots or streaks above the antennæ are small and sometimes inconspicuous; the mouth-edge is usually black, but there is only a trace of the middle facial line."

"Thorax brilliantly shining."

"Abdomen more ovate than in *S. nitidicollis,* with the basal pair of spots less sharply triangular, while the undulating bands are broader and may just indistinctly touch the side-margins at their upper corners, though not enough to cause pale marginal pubescence; the peculiar ventral spots seem very much as in the male."

"Legs paler than in the male, as in the original specimen upon which the species was introduced as British they are entirely orange down to the base of the femora, but usually the basal fifth of the anterior, and the basal two-fifths of the hind, femora are black; tarsi as in the male."

"Wings rather more orange than in the male..... Length about 10.5 mm.....Rare."

In the Maine males the face across the knob with a black stripe, abbreviated much short of the base of the antennæ, prominent in all except one specimen. This stripe is continuous with the narrow black margin of the anterior mouth-edge. The latter black stripes turned obliquely outward toward the eye, cutting off a small, triangular, yellowish spot next the mouth edge before the jowls which are again all

black and across behind the mouth. Pubescence behind the eyes whitish below, orange above.

Spots on the second abdominal segment in most specimens quadrangular rather than triangular. All the yellow bands distinctly separated from the side margins. The bands on the third and fourth abdominal segments, in both male and female, on the middle line, with a small anteriorly and posteriorly directed pointed projection, not shown in Verrall's figure 296.

The anterior femora are black on the basal fourth, the hind femora on a little more than the basal half.

In the females the lunate, black spots above the base of the antennæ are rather prominent and, in one specimen, almost continuous with the widened black extension from the vertex. The black stripe over the facial knob is present but the stripes across the cheeks not developed, the latter yellow to the jowls.

Hind femora entirely yellow the anterior ones black on about the basal sixth. The third joint of the antennæ in both sexes only a little longer than deep after the end of the second joint.

Didea fasciata Macq. var. fuscipes Loew.

(See also 30, p. 337, 34, p. 90 and 35, p. 58.)

This species which in Ohio I have found breeding only on *Longistigma caryae* infesting sycamore and basswood, was found among the Willow Grove Plant-louse (*Pterocomma flocculosa*) on the University of Maine campus the last of July and first of August, at which time most of the larvæ were full grown. Pupation took place about August 10. Adults were captured July 15 about infested twigs of green apple aphis (*Aphis pomi*).

The following descriptions are abbreviated from my previous publications on this species (30; 34, p. 90; 35, p. 58).

Egg. (Fig. 29-5). Of about the usual shape; broadest about the middle. Length 1.3 to 1.7 mm., diameter 0.4 to 0.6 mm. Color chalk white. The chorion is sculptured in a characteristic manner. The projecting bodies are close together, not highly elevated, each one two to four times as long as broad. There are 55 to 60 of these bodies lengthwise of the egg and 80 to 100 around it at the middle. The egg of *Didea* differs from all the others I have seen in that the projecting bodies are not smooth on the top but each one has a small number (6-10) of more or less angular, irregular-shaped, pit-like depressions hollowed out of it. These are so arranged as to leave between them an elevated part of the body with more or less parallel sides. The whole effect is to give the arm-like network appearance over the elevated body somewhat like that between these bodies, without the outlines of the bodies being obscured. The arms between these bodies are irregular,

slightly branched, for the most part rather short, sometimes long, from 10 to 15 radiating from each body.

Larva (Fig. 35-*2, 3, 4, 5*). Length, 12 to 15 mm., width 5 to 6 mm., height 3 to 4 mm.; testaceous brown; flattened, sub-cylindrical, blunt at the posterior end, tapering and obtusely pointed in front when extended (Fig. 35-*2*). The head segments usually much retracted giving to the anterior end a bluntly rounded appearance. Each of the body segments, except the first two and the last, with several transverse folds of the integument and a transverse row of twelve segmental bristles each about .15 mm. long. The median and dorsal ones crown the summits of conspicuous, conical elevations which, like the rest of the dorsum, are close-set with short, radiating, black, integumental bristles about .065 mm. long. The transverse body wrinkles are continued laterally into distinct V-shaped prominences bearing the dorso-lateral segmental bristles and forming a zig-zag longitudinal carina along each side of the body. The lateral segmental bristle is situated at the apex of a similar cone or V underlying the dorso-lateral; and in front of it a small ventrally-directed fold bears the two ventro-lateral segmental bristles on smaller spiny prominences. The lateral border has thus a very irregular outline of sharp angular projections.

Mouth-parts with three pairs of small thorns close beside the V-shaped jaws. The prominent lateral mouth-hooks, found in so many aphidophagous species, wanting.

In the middle of the third segment is a pair of anterior spiracles. These are light brown, conical, with a semi-circular slit near the apex (Fig. 35-*4*).

On the dorsum of the last segment is situated the posterior breathing organ (Fig. 35-*2, b; 5*). This consists of two closely apposed, short, cylindrical breathing-tubes, united along the middle line, slightly divergent at the tip. They are hard, black, firmly chitinized structures, each with three slit-like spiracles raised on radiating carinæ. Dorsad near the middle line each is marked by a smooth circular plate about .09 mm. in diameter, their inner margins about .175 mm. distant from each other. The surface of the stigmal plates between the spiracles is very much roughened the inter-spiracular ornamentation consisting of thin laminate ridges, about as high as the carinæ, on which the spiracles are located; only the summits of these ridges are indicated in figure 35-*5*; about two such ridges on each interspiracular space and continued down the sides of the short tube. The median spiracle at least .25 mm. in length and slender.

The integument of these larvæ is exceedingly tough but transparent. The entire dorsal and lateral surfaces are beset with numerous, minute, short black bristles. The ventrum is bare. Along the mid-dorsal line for the greater part of its length the dorsal blood-vessel is visible through the body-wall. It is a poorly-defined, dark line with five or six lateral expansions.

As the larva approaches metamorphosis the anterior segments are retracted, the skin becomes inflated filling out the wrinkles character-

istic of the larva. It rounds out anteriorly and dorsally, the point midway between the fourth and fifth segments coming to lie at the anterior pole, the mouth being shunted backward on the ventral side. The pupa is concealed in this indurated, inflated, sub-ovate, larval skin or puparium.

Puparium (Fig. 35-6, 7). Length 9.5 to 10 mm., width 4.5 to 5 mm., height about 4.5 mm. Color, Roman sepia, a little darker than the larva. Broadest a little back of the sixth larval segment, nicely rounded in front, tapering gradually to the last segment which remains somewhat flattened, especially at the sides. The covering of small black bristles is retained and the black conical prominences become even more conspicuous owing to the inflation (Fig. 35-6, 7). The posterior breathing appendages retain the larval condition.

Adult (Fig. 35-1). Description slightly modified from Williston (62, p. 89). ♀ ♂ Length 11-15 mm. Face yellow, with a small elongate brownish spot on the tubercle. Front yellow, with two brownish spots above the antennæ, or, in the female, with an inverted V-shaped brown stripe connected with the black of the upper part of the front. Eyes bare. Orbits thickly yellowish pollinose, posteriorly with a fringe of yellowish-whitish pile. Antennæ black, the third joint at the base sometimes reddish, elongate oval, obtusely pointed at the tip; arista reddish. Thorax shining greenish black, on the meso-, ptero-, and sterno-pleuræ yellow, thickly covered with similar colored pollen and pile. Scutellum light yellow, translucent. Wings grayish hyaline, the base before the humeral cross-vein and the stigma brown; the remainder of the subcostal cell and the costal cell may be brownish; third vein rather deeply curved near the middle of the first posterior cell. Legs brown, the posterior tibiæ and all the tarsi blackish; sometimes the legs are luteous, the base of femora, distal portion of tibiæ, and the tarsi brown. Abdomen black, with four yellow cross bands, the first consisting of two large ovate spots, narrowly separated and reaching the lateral margins in nearly their full width; second and third cross-bands broad separated from the lateral margins by a black narrow keeled border; they are much narrower in the middle of the segments, the front margin straight, touching the anterior edge of the segments; fourth band similar, but much smaller and attaining the margin; all the black is velvety opaque except the narrow posterior margin of the segments which is shining, dilated in the middle.

Tropidia quadrata Say.

This common, widely distributed species has been well known for many years, but no record has been made of the larval habits of this or any other species of the genus. No record had been made of its immature stages previous to the description by Mr. J. R. Malloch in December, 1915 (28, p. 343), of

the *puparium* which was found floating on the water of a lake. The larval habit was not determined.

On July 7, 1915, at Orono a larva of this species was collected in partially decomposed human excrement near the mouth of a sewer. It was apparently full grown by July 19, pupated between the 21st and 27th and emerged from the puparium August 6.

On July 10 a gravid female was captured at the same spot and enclosed with a male over a small mass of the moist excrement. By one o'clock of the same day a mass of several hundred eggs had been deposited by this female. By July 14, 7 A. M., nearly all of the eggs had hatched and the young larvæ were submerged except for the posterior respiratory appendage in the moisture at the bottom of the jar. The larvæ were kept in cages and were about full grown on September 9. Three hundred and eighty-seven eggs were dissected from the ovaries of a female taken about human excrement on July 21. On July 27 seven puparia were taken from the drier parts of the mass of excrement. One of them which had apparently just pupated emerged August 8; others from July 28 to August 1.

Egg. (Fig. 36-*1, 2 3*). Sub-cylindrical, elongate-ovate in outline, a little smaller and more truncate at the micropylar end, slightly curved on its long axis. The length of specimens measured varied from .82 to .86 mm., with an average of .84 mm; the maximum diameter was very uniformly .255 mm. Color white, glistening. The markings or sculpturing of the chorion (Fig. 36-*2*) are characteristic, although approached closely by *Syritta pipiens* (See p. 253). It consists of small, irregular, polygonal areas, which are slightly raised, leaving between them narrow, parallel-sided and rather smooth-sided channels; the latter connecting with each other to make a fine dark network over the surface of the egg. Each of the areas thus marked off is further ornamented on its surface with about 20 to 40 circular areoles by the slight depression of the surface between them. When viewed under very high power (oil-immersion objective and 3-4 inch ocular) the minute circular areoles are seen to be formed by the arrangement of very fine finger-like elvations, (Fig. 36-*1*).

The polygonal areas are of such a size that about thirty occur end to end the length of the egg and about fifty or sixty side by side around it.

Egg-laying was observed from July 10 to July 21; but, since a good-sized larva was found as early as July 7 and since adults continued to emerge at least until August, the egg-laying

period is doubtless much more extended. In the case observed (laboratory) the egg-stage lasted between 72 and 90 hours.

Larva (Fig. 36-*4, 5 6, 7*). At a very early stage (2 or 3 mm. long) the young larva shows the characteristics of the full grown one, seemingly differing only in size. Full grown larva about 16 mm. long; maximum width 3.75 mm., maximum height 3.5 mm. Nearly cylindrical, broadest in the middle; the anterior segments forming a globose, false head; the posterior segments tapering rather rapidly throughout the caudal eight (about 2 mm.) of the length to the posterior respiratory appendage. The latter structure terminal; about .75 mm. long, .66 mm. broad at its base, .5 mm. broad at its apex, and about .4 mm. high. The double nature of the appendage indicated by moderate impressions on the mid-dorsal and mid-ventral lines.

The distal end is truncated, and the stigmal plates ornamented with a pair of circular plates, three pairs of spiracles and four pairs of palmately-divided, plumose, interspiracular hairs. The circular plates occupy nearly a median position, dorso-ventrad, and are situated near the median line. Each has a diameter of .085 to .095 mm. and their inner margins are less than .02 mm. apart. The spiracles are roughly S-shaped, each ornamented with about twenty short, rounded, lateral denticles, irregular in size and irregularly distributed. The right median spiracle forms an S, the left one a reversed S. In other words the dorsal free end of the S on either stigmal plate is directed laterad, the ventral free end, mesad. The interspiracular ornaments consist each of about five plumose or feathered hairs arranged palmately. Some of the hairs are further divided; all are united at the extreme base; and occasionally two are united for some distance from the base.

Immediately cephalad of the posterior respiratory appendage at each side of the twelfth segment are three fleshy, conical lateral protuberances, the posterior one about .75 mm. long, the others about half that length, each pair connected by a prominent wrinkle across the dorsum of the segment. The first four body-segments composing about the anterior sixth of the body (2 or 3 mm.) is head-like globular, and separated by a slight neck-like constriction from the succeeding segments; with several faint longitudinal furrows on its sides. At the anterior end this false-head bears a pair of small antennæ, each of a fleshy base, surmounted by two, minute, sub-equal, rounded nodules side by side at its apex. Just ventrad of the antennæ is a rounded, somewhat-chitinized mouth-hood, concave ventrally, within which is the buccal cavity. The mouth opening further guarded by a fleshy fold at each side, covered with long flexuous hairs, of service in straining the food. The dorsal part of the bulbous false-head is ornamented with a characteristic group of black, chitinous hooks or thorns. There are two large hooks about .25 mm. long on each side, situated about one millimeter dorso-laterad of the mouth-hood, their bases about .35 mm. apart. Extending between, and dorsad, of them are three irregular, transverse rows of smaller and various-sized thorns, most of them

barely visible to the naked eye. The most posterior of these rows (Fig. 36-7*A*) consists of a large thorn at each side and six to ten smaller ones between them. In the middle row near each side, and looking much like a thorn, is located the sessile, anterior larval spiracle (Fig. 36-7*B*). There is a small hook or thorn laterad of each spiracle, a large one mesad and, between the latter, about three smaller ones. The anterior row consists of six to ten thorns of moderate size. Cephalad of these three rows and above the mouth-hood is a semi-circular band of numerous microscopic hooklets. The surface of the anterior larval spiracle bears four rounded nodules.

The entire surface of the body is covered with microscopic, close-set, pale brown, short, soft hairs. The segmental hairs are longer flexible and about three in a clump. Eight transverse rows of them can be made out posterior to the anterior spiracles. The body segments are further indicated each by a group of about four transverse wrinkles. About seven pairs of prolegs, consisting of ventral fleshy projections, each bearing a clump of recurved hooklets; five pairs on segments five to nine, inclusive, about equally developed and with a dozen or more hooklets, the anterior ones largest; one pair on the venter of the third segment which usually has fewer hooklets, and a smaller pair on segment ten. The anus is a prominent transverse slit about 2 mm. cephalad from the base of the posterior respiratory organ, on the venter of the eleventh segment.

Color dirty white or clay yellow.

Under laboratory conditions the larval period extended over about two months from July to September. Although the larva has been found only in human excrement, there is no reason to believe it would not develop in other kinds of filth or decaying material.* The larvæ were found in the moist, but not watery, portions of the mass and several inches beneath the surface.

Puparium (Fig. 36-*8, 9, 10*). Pale brown. Length 8 to 9 mm; maximum width 3.25 to 3.75 mm.; maximum height 2.75 to 3.25 mm. Broadest a little in front of the middle where it is nearly circular in cross-section. Only a little narrowed and globose in front, but evenly tapering caudad to about one-third the width just in front of the posterior respiratory process. As viewed from the side, ventral line nearly straight to within about two millimeters of the posterior end, thence elevated; the dorsal line a little more strongly and abruptly elevated anteriorly than posteriorly.

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*Since writing this, I have found the larvæ and puparia at Presque Isle and Houlton, July 8 and 9, in masses of rotting potatoes which had beep swept out of store-houses and allowed to lie on the ground until well-decayed. Adults emerged from the puparia, July 19 and 20.

Many adults were noted hovering—apparently for the purpose of oviposting—about the above masses and also about decaying masses of "sprouts" from potatoes used in planting.

The anterior end bears, in addition to the characteristics remaining from the larval stage, a pair of pupal respiratory cornua situated well dorsad, their bases about .75 mm. apart (Fig. 36-*8A, 10A*). Each cornuum strikingly like a common species of morel mushroom in appearance; about .4 mm. broad and .5 mm. long, the basal third or fourth slenderer. Its surface bears a hundred or more of minute papillæ each when very highly magnified (Fig. 36-9) showing a further ornamentation of its surface with five to eight nodules.

The buccal hood of the larva occupies a position at the anterior extremity of the ventral line (Fig. 36-*10C*), and although they are much less conspicuous, the arrangement of thorns and hooklets remains essentially as in the larval stage. For the emergence of the adult the anterior end splits into a two-piece operculum; one transversely elongate piece surrounding the pupal respiratory cornua; the other an ovate piece, cephalad of this and including the anterior larval spiracles, but not the two pairs of largest hooks. The posterior end of the puparium much as in the larva; the respiratory process terminal and, at each side of it, the three pairs of lateral processes of the body-wall, somewhat shrunken and indurated. Slight traces of the transverse wrinkling remain and on careful examination the larger hooklets of the prolegs can be distinguished.

The duration in the pupa stage was between 9 and 15 days, this stage being noted during late July and early August. The pupæ were found a few inches under the surface in the moderately-dry parts of the excrement in which the larvæ had fed. Pupation is accompanied by the induration of the larval skin with chitin and the great inflation especially of larval segments five to eleven.

Adult (Fig. 36-*12, 13, 14*). *Eyes bare, face with a median keel-like ridge, marginal cell open, third vein curved, anterior cross-vein beyond the middle of the discal cell; hind femora extraordinarily thickened with an angular projection below near outer end; abdomen of nearly equal width.*

Length 9 to 12 mm. Front in female narrow above; face gently convex in profile in the male, a little concave near the middle in the female; densely covered with yellowish gray pollen, leaving a slender median stripe and a spot on the cheeks black. Antennæ yellow, third joint nearly square. Dorsum of thorax shining, greenish black, with two rather distinct median pollinose stripes in front, two spots of the same colored pollen in front of the scutellum, another in front of each postalar callus, on the humeri, and a spot along the dorso-pleural suture immediately behind the humeri. Scutellum yellow along the border. First abdominal segment black, yellow on the sides; second segment in front (but not reaching the sides) and a narrow median stripe black, behind extending narrowly to the sides, more brownish, forming an inverted T; third segment with a similar T but more brownish, less distinct. In the female the black on the second segment

is broader, the third segment black except a quadrangular spot in front on each side. Front and middle legs yellow, except on the basal half or more of the femora, black; hind legs black, the knees only yellow. Description adapted from Williston (62, p. 207) and Verrall (55, p. 571).

Syritta pipiens Linné.

This is one of our most abundant and wide spread species, apparently occurring throughout most of Europe and North America and common from spring to autumn. It has been recorded breeding in horse-dung and cow-dung in Europe (17), and Dr. L. O. Howard has noted the capture (but not the rearing) of an adult about human fæces.

The larvæ were found breeding in large numbers in moist masses of guinea-pig manure in the animal room at Ohio State University during the winter and spring of 1915. On July 7 at Orono, two puparia were taken from a drying mass of human excrement at the opening of a sewer. Adults emerged from them August 2 and 3. On July 7 and 12 a number of females were found hovering about the above-mentioned mass of filth. Two of them were enclosed in a vial and had soon deposited a mass of several hundred eggs. They began hatching on July 16, the duration in the egg-stage having been almost exactly four days.

This species in all its stages shows a close resemblance to *Tropidia quadrata* and it will be described in comparison with that species.

Egg. (Fig. 37-1, 2, 3). Sub-cylindrical, tapering toward the ends; the micropylar end somewhat truncate, the opposite end rounded out; nearly straight on the ventral side, somewhat rounded up dorsally. Dimensions (ten specimens): Length .6325 to .6875 mm., average .665 mm.; maximum diameter .213 to .24 mm., average .23 mm.

The sculpturing of the chorion consists of polygonal elevated areas, separated by narrow depressed lines which form a darker network over the entire surface. About thirty such elevations the length of the egg, fifty to sixty around it. With higher magnification (1-4 in. objective) these elevated areas are seen to be finely papillose, and on closer examination the papillæ are seen to be grouped into areoles of greater elevation, with depressions between them. As contrasted with *T. quadrata*, it is evident that the grouping of the papillæ into definite rounded areoles is much less pronounced and that the areoles are much more irregular in shape (Fig. 37-2; cf. fig. 36-1). For example on the egg of *T. quadrata* the areoles are quite easily seen with a 2-3 in.

objective; while in *Syritta pipiens* they are hardly made out with less than a 1-4 in. objective and are not as definite at any magnification. Color white.

Larva (Figs. 37-4, 5, 9). Superficially resembling the larva of *T. quadrata,* especially in the differentiation of the anterior segments into a false-head and in the possession of three pairs of lateral fleshy projections just anterior to the short, posterior respiratory process. It differs from *T. quadrata* in its much smaller size, in being less nearly cylindrical, broader in the median segments, and somewhat flatter; the posterior respiratory organ is relatively longer and slenderer and the constriction between segments three and four (at the side of the false head) more marked.

Length about 10 mm., maximum width about 2.75 mm., maximum height about 2 mm. Broadest in the region of segments seven to nine. Tapering moderately backward to less than half the width at the base of segment twelve; much more moderately toward the head. The false head 1.75 to 2 mm. broad, not as well developed as in *T. quadrata.* Color dirty yellowish. The entire integument covered with pale and delicate, close-set microscopic hairs, longer on the more exposed portions. The false head lacks the conspicuous hooks or thorns of *T. quadrata,* the vestiture being specialized only into the transverse band of microscopic hooklets above the mouth. Antennæ, mouth-hood and lateral mouth-folds not differing noticeably from *T. quadrata.* The false-head with about a dozen longitudinal furrows, one on the mid-dorsal line. The anterior larval spiracles located between the first and second furrow from the mid-dorsal line, sessile; each apparently with three rounded nodules on its summit. There are seven pairs of prolegs on segments 3 and 5 to 10, inclusive, the first pair situated more widely apart than the others, the last pair smaller, each with about two dozen hooklets of varying size.

The posterior respiratory organ is a brown, chitinized, polished tube, projecting about .75 mm. (.5 to 1 mm.) its width ranging from .25 to .35 mm., its depth from .2 to .25 mm. A little broader at base than at apex, the latter truncated. The tube is semi-transparent and the two large tracheal trunks can be seen throughout its length. The stigmal plates similar to those of *T. quadrata* but with distinct differences. The most important difference is that the three pairs of spiracles are less distinctly S-shaped and each is ornamented with from nine to fourteen (compared with about twenty for *T. quadrata*) of rounded lateral projections or denticles irregular in size and irregularly distributed.

Puparium (Fig. 37-6, 7, 8). Dimensions (15 specimens): Length, inclusive of the posterior respiratory appendage which retains the same dimensions as in the larva, 5.9 to 7.9 mm., average 6.8 mm.; maximum width 2.75 to 3.4 mm., average 2.95 mm.; maximum height 2.65 to 2.95 mm., average 2.68 mm. In outline elongate ovate, a little more attenuated posteriorly, this attenuation more pronounced than in *T. quadrata.* Nearly circular as seen from in front a little flattened on the venter. The ventral line as seen from the side, straight from mouth-

parts almost to the posterior respiratory process before which it becomes a little elevated. The dorsal line begins with a very sharp, nearly rectangular elevation in front, followed by a gentle flexure reaching its greatest height a little in front of the middle. The descent is gradual throughout the third quarter of the length, thence more abruptly to the posterior respiratory organ.

The pupal respiratory processes (Fig. 37-*6A, 8*) penetrate the puparium near the antero-dorsal flexure, about 2 mm. from the ventral line and half a millimeter caudad. Each measures .35 to .5 mm. in length, maximum diameter about .2 mm. Morel-shaped, the proximal half being somewhat more slender, the distal half dilated and studded with about seventy-five minute nodules. Each of these nodules when very highly magnified (Fig. 37-*7*) is seen to consist of four, five or six oval elevations each with a median slit. The anterior face of the expanded part traversed by a branching shallow groove. The clumps of hooklets on larval prolegs are conspicuous along the mid-ventral line and the posterior respiratory process retains its larval characteristics.

Adult (Fig. 37-*10, 11*). *A small slender, nearly bare, fly, black with yellow markings and very thick hind femora; marginal cell open, third vein gently curved, anterior cross-vein near the middle of the discal cell.* Description adapted from Williston (62, p. 240) and Verrall (55, p. 612).

Length, 7 to 8 mm. Face and front satiny yellowish white. Front of female narrow above, shining black, with two small pollinose spots; vertical triangle of male elongate. Antennæ reddish yellow. Dorsum of thorax black, nearly bare, in front with two approximate pollinose spots. The humeri and to the suture and all the pleuræ yellowish or whitish pollinose. Abdomen: opaque black in front, shining behind; narrow sides of first segment and a broad spot at each side of the second, yellow, somewhat whitish pollinose. "At the extreme produced base of the second segment a remarkable fringe of whitish hairs, ... the only obvious pubescence on the abdomen" (55, p. 613); third abdominal segment with a smaller yellow spot at each basal corner and the fourth with a narrow, interrupted yellowish-white pollinose cross-band, the hind margin narrowly yellow. In the female the spots smaller, the sides of the third segment in front metallic, scarcely at all yellow, but with a light pollinose spot. Legs yellowish-red with obscure brownish markings; hind femora black, with the base and a usually incomplete ring near the middle, reddish yellow; hind tibiæ at the middle and tip brown or black.

Artificial Keys to the Known Larvae and Pupae of Syrphidae

KEY TO TYPES OF LARVAE

1. Body terminating in a long, flexible and extensile, rat-tail-like respiratory appendage (often longer than the body). Larvae aquatic, semi-aquatic, or living in moist decaying materials. The puparium with a pair of prominent, anterior, respiratory cornua (See also p. 210) .....
IV. THE LONG-TAILED FILTH-INHABITING TYPE (Genera *Eristalis, Helophilus, Chilosia, Chalcomyia, Sericomyia, Mallota,* etc.)

Posterior respiratory appendage considerably shorter than one-fourth the length of the body, rigid. Habits various, but not aquatic larvae 2

2. Larvae short-oval or rounded in outline, convex above, and with a very flat, creeping-sole, ventrally, around which is a fringe of spines. The shape constant and sub-hemispherical; no evident transverse wrinkling of the body-wall, but the dorsum often nicely reticulated. Larvae living in ant-nests. The puparium sub-hemispherical, and with prominent anterior cornua. (See also p. 211) .....
.....V. THE MICRODON TYPE (Genus *Microdon*)

Shape of larva elongate-oval with the venter flattened, or sub-cylindrical; the outline not constant, but the body especially the anterior end, capable of considerable extension when active 3

3. Body nearly cylindrical, the anterior end not attenuated, but rounded out, forming a false-head. Three fleshy, finger-like processes at each side of the last body-segment. No external mouth-parts. Puparium with prominent anterior cornua. (See also p. 210) .....
III. THE SHORT-TAILED FILTH-INHABITING TYPE (See key below)

The anterior end of the body considerably attenuated, when active; no false-head. Black, chitinized mouth-parts present.....4

4. Body nearly circular in cross-section. Mouth-parts of two recurved hooks, uniting basally into a mouth-hood. Stigmal plates with groups of minute, palmately-arranged, plumose hairs. (See also p. 209).....
.....II. THE BORING TYPE (*Merodon equestris* Fabr.)

Body always noticeably, often much, flattened. Mouth-parts of two, A-shaped jaws. Stigmal plates with various ornamentation but not with plumose hairs. Puparium rounded in front, attenuated behind, and apparently without pupal respiratory cornua (See also p. 208) .....
.....I. THE APHIDOPHAGOUS TYPE (See key below)

I. THE APHIDOPHAGOUS TYPE

Key to Species

1. Dorsal pair of slit-like spiracles much shorter than the other pairs, its carina rounded. Larvae phytophagous .... *Toxomerus politus*, p. 216.
All the slit-like spiracles elongate, at least several times as long as broad, or at least the dorsal pair not conspicuously shorter. Larvae aphidophagous 2
2. Posterior slit-like spiracles greatly elongate and extensively sinuate or undulate. (Fig. 34-3) .....*Syrphus nitens*, p. 242.
Posterior slit-like spiracles straight or somewhat curved, never much sinuate 3
3. General color greenish, with white longitudinal stripes. Rather smooth-bodied larvae with no integumental vestiture and the segmental spines not prominent 4
General color yellowish, reddish or brownish 6
4. Posterior respiratory organ less than half as long as broad. Slit-like spiracles less than twice as long as broad. Viscera usually plainly visible thru the skin. (Fig. 30-5 and 6) ....*Melanostoma mellinum*, p. 226.
Posterior respiratory organ considerably longer than broad. Slit-like spiracles each at least three times as long as broad.....5
5. Stigmal plates roughened, the spiracles well elevated and separated by spur-like elevations. The two tubes very slightly divergent at the tip. (Fig. 31-66 and 68) ....*Allograpta obliqua*, p. 234.
End of posterior respiratory appendage nicely rounded off, smooth, the spiracles not elevated, and not separated by perceptible spurs. The two tubes not at all divergent. (Fig. 31-72 and 73). .....*Sphaerophoria cylindrica*, p. 231.
6. Integument of the larva bare except for the segmental spines.....7
The entire dorsal surface of the larva covered with short, microscopic spines, black, or sometimes light in color and then not prominent 8
7. Posterior respiratory appendage longer than broad; inter-spiracular nodules rather prominent..... .....*Syrphus xanthostomus* (34, p. 81).
Posterior respiratory appendage broader than long; inter-spiracular nodules not prominent. (Fig 33-13) ....*Syrphus torvus*, p. 240.
8. Segmental spines conspicuous or raised on prominent, fleshy or spiny, conical elevations easily seen by the naked eye 9
Segmental spines not prominent and not raised on conspicuous, conical projections; sometimes hard to distinguish from the integumental spines 11

9. All of the segmental elevations and segmental spines, on the dorsal surface of the body, of nearly equal size. The inter-spiracular spaces on the stigmal plates with lamellate, upright ridges. (Fig. 35-*2* and *5*) .....*Didea fasciata fuscipes*, p. 246.

   The dorsal, segmental elevations (ones next the median pair) in the principal body-segments much reduced in size. The dorsal spiracular nodule long and prominent; the other inter-spiracular spaces with small nodules or delicate hairs.....10

10. Posterior respiratory appendage broader than long .....
.....*Paragus bicolor* (31, p. 397).

    Posterior respiratory appendage considerably longer than broad.
.....*Paragus tibialis* (31, p. 402).

11. Integumental spines black. Inter-spiracular spaces with short, stout, black spurs. (Fig. 32-*46*, *49* and *50*) .....
.....*Syrphus americanus*, p. 236.

    Integumental spines light yellow. Inter-spiracular spaces with long slender hairs. (Fig. 29-*2*) .....*Pipiza pisticoides*, p. 224.

III. THE SHORT-TAILED FILTH-INHABITING TYPE

Key to Species

1. False-head of larva without any conspicuous, black, anterior thorns or chitinized hooklets. Posterior respiratory appendage about three times as long as broad. The spiracles on stigmal plates with about ten lateral denticles. (Fig. 37-*5* and *9*).....
.....*Syritta pipiens*, p. 253.

   Antero-dorsal part of false-head ornamented with black hooks or thorns, visible to the naked eye. Posterior respiratory appendage less than twice as long as broad. The posterior spiracles with more than fifteen lateral denticles 2

2. Two prominent hooks on each side of the false-head, their bases united into one chitinous plate. The posterior spiracles with forty to eighty lateral denticles.....*Zelima* (*Xylota*) *pigra*.

   Two prominent hooks on each side of the false-head, their bases separated by a little more than their length; also several transverse rows of slightly smaller thorns between these pairs. The posterior spiracles with fifteen to thirty lateral denticles. (Fig. 36-*5*, *6*, *7* and *8* .....*Tropidia quadrata*, p. 248.

Glossary of New or Unusual Terms.

Anterior larval spiracle: The breathing pore, or opening to the trachea, situated at the side of the third body segment of the larva (Figs. 34-*2*; 32-*46b*; and 36-*5B*).

Anterior stigmata: See anterior larval spiracle or pupal respiratory cornua.

Areoles: As applied to the sculpturing of the chorion or egg-shell, a minute differentiated spot on the surface of a *body* (q. v.).

Arm: As applied to the sculpturing of the chorion or egg-shell, a slender, root-like, elevated process from a *body* (q. v.), extending into the depression between the bodies.

Aschiza: (Brauer) a section of the dipterous sub-order Cyclorrhapha in which the frontal lunule and suture above the root of the antennæ are wanting. It includes the families Syrphidae, Pipunculidae, Platypezidae and Phoridae.

Body: As applied to the sculpturing of the chorion or egg-shell, a microscopic elevated area surrounded by a depression.

Carina: An elevated ridge; see dorso-lateral carina, ventro-lateral carina; and also under slit-like spiracle.

Circular plate: "Button" of authors: a usually smooth, or roughened, circular or oval area of the stigmal plate situated, typically, dorso-mediad on the latter; and usually distinct in color or texture from the rest of the stigmal surface; sometimes partially or completely surrounded by a ridge (Figs, 30-*5B;* 34-*3A* and 36-*6B*).

Cyclorrhapha: (Brauer) a sub-order of the Diptera in which the larvæ lack a differentiated head; the pupæ are always enclosed in the hardened larval skin or puparium, from which the fly escapes through a circular orifice or operculum at the anterior end.

Dorsal line: The upper margin of the puparium, when viewed from the side, extending from the position of the larval mouth-parts in front, dorsally around to the base of the posterior respiratory process behind.

Dorsal spiracular spine, ridge or nodule: A chitinous elevation of the stigmal plate mesad from the circular plate (q. v.) (Fig. 32-*50a*).

Dorso-lateral carina: An irregular, longitudinal, zig-zag ridge along the side of the body of the larva (formed by the fusion of the ends of transverse folds of the integument) above the ventro-lateral carina, and bearing the dorso-lateral segmental bristles of successive segments.

False-head: A globose grouping of the anterior segments of certain larvæ, partially constricted from the succeeding segment.

Integumental vestiture: Minute, close-set, short, microscopic hairs or bristles covering the integument of the larva at least on the dorsal surface; contrasted with the segmental vestiture (q. v.).

Interspiracular ornamentation, hairs, spines, spurs, nodules, ridges, or lamellae: Armature of various kinds occurring in the interspiracular spaces (q. v.). See also, dorsal spiracular spine.

Interspiracular spaces: The areas between and around the slit-like spiracles on the apex of the posterior respiratory process. These are four in number on each stigmal plate; one between the dorsal slit-like spiracle and the circular plate; one between dorsal and median spiracles; one between median and ventral spiracles; and one mesad from the ventral spiracle.

Jaws: Of aphidophagous larvæ, a pair of chitinized, A-shaped lips above and below the mouth-opening (Fig. 30-*4C*).

Jowls: The part of the head below the cheeks and the eyes (Wingate); also known as the cheeks or genæ.

Lateral mouth-hooks: Heavy, black, chitinized, curved hooks or thorns on the head segments but separated from the jaws by an intervening space, in which respect they differ from the mouth-hooklets (q. v.), as also in being usually shorter and broader at the base (Figs. 30-*4A*; 31-*67c*; and 33-*11c*).

Mouth-hood: A dorsally convex, ventrally concave, chitinous termination of the cephalo-pharyngeal skeleton of the larvæ of certain types, which covers the anterior opening of the alimentary canal. (Fig. 34-*7F*).

Mouth-hooklets: Chitinized, black, microscopic thorns, elongate and slender or short and thick, situated closely at the sides of the jaws and evidently of assistance in prehension (Figs. 33-*11d*; and 35-*3c* and *d*).

Posterior larval spiracles: See posterior respiratory organ.

Posterior respiratory or breathing organ, appendage, tube or process: An appendage borne terminally or dorsally on the twelfth (last) larval segment, consisting of two tubes more or less completely fused mesad throughout their length, enclosing two large tracheæ and bearing on their ends the posterior larval spiracles (q. v.) through which the tracheæ open. This tube is considered for descriptive purposes to have been originally a terminal appendage; consequently its *length* is the distance from its base (where the tube becomes differentiated from the last segment) to its apex; its *width* is the maximum transverse diameter across both stigmal plates (q. v.); and its *depth* or *height* is the maximum dorso-ventral distance at the tip when oriented as described above; (when the tube is very short and directed dorsad, what appears to be the cephalo-caudad distance).

Pupal respiratory cornua: A pair of chitinous terminations of the tracheæ leading to the prothorax of the developing fly, which are pushed through the puparium, dorso-cephalad, for respiration during the pupa stage. Their surface bears a few or many denticles or papillæ about which the air enters. Sometimes very conspicuous, sometimes (especially on the puparia of aphidophagous larvæ) exceedingly minute and indistinguishable (Fig. 30-*7A*).

Segmental bristles, hairs, spines or vestiture: A transverse row of more or less prominent hairs or other armature, specialized from the integumental vestiture (q. v.) across the dorsum and sides of each larval segment. These hairs are twelve in number, and for convenience in description, I have named them in order, beginning with the pair nearest the mid-dorsal line and proceeding laterad and ventrad: a, *median;* b, *dorsal;* c, *dorso-lateral;* d, *lateral;* e, *posterior ventro-lateral;* and f, *anterior ventro-lateral.*

Segmental elevation or cone: A more or less prominent conical fleshy elevation subtending a segmental bristle (q. v.).

Slit-like spiracle: One of the three pairs of openings of the tracheæ at the posterior end of the body of the larva, on the stigmal

plate (q. v.); usually straight or slightly curved but often sinuate, convoluted or undulated, and may bear lateral projections or denticles. They usually radiate and are usually elevated on carinæ. They are named dorsal, median and ventral pairs the former usually nearest the circular plate.

Spiracle: An opening to a trachea, or breathing pore. See anterior larval spiracle, slit-like spiracle, stigmata.

Stigmal plate: Either half of the truncated apex of the posterior respiratory process, usually separated from the other lateral half by a distinct median dorso-ventral incision. It bears three slit-like spiracles (q. v.), the circular plate, and the interspiracular ornamentation.

Stigmata: See spiracle, pupal respiratory cornua.

Ventral line: The margin of the puparium, when viewed from the side, extending from the position of the larval mouth-parts in front, along the venter to the base of the posterior respiratory process at the posterior end.

Ventro-lateral carina: An irregular, longitudinal, fleshy ridge along the side of the body of the larva underneath the dorso-lateral carina and bearing the lateral segmental bristles.

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FIGURES AND EXPLANATIONS

EXPLANATION OF FIGURE 29.

Pipiza pisticoides Willist.

1 Side view of larva x12; A, lateral mouth-hook, immediately in front of which is the antenna; B, anterior larval spiracle; C, posterior respiratory process.
2 End view of posterior respiratory process x185; showing the two stigmal plates, each with a circular plate, interspiracular hairs and slit-like spiracles.
3 Side view of puparium x12.
4 Dorsal view of adult female x18.

Didea fasciata Macq. var. *fuscipes* Loew.

5 Sculpturing on egg-shell of *Didea fasciata fuscipes* (q. v.)

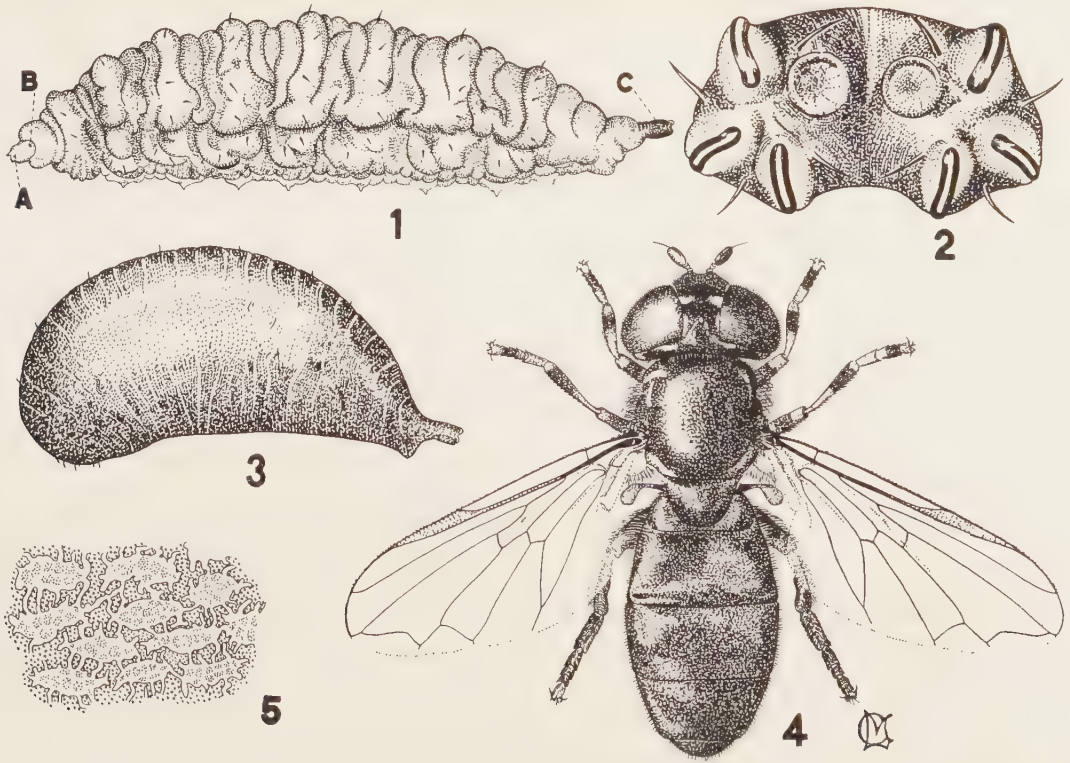

Fig. 29. Life-stages of *Pipiza pisticoides* Willist.

EXPLANATION OF FIGURE 30.

Melanostoma mellinum Linné.

1 Masses of eggs as deposited by female on leaf of rape x12.

2 Egg-mass from another female, showing the characteristic ranking of eggs side by side, x12.

3 A small area of the egg-shell highly magnified, showing nature of sculpturing.

4 Ventral view of head-segments of larva much enlarged; A, lateral mouth-hook; B, antenna; C, upper jaw; D, anterior larval spiracle.

5 End view of posterior respiratory organ x 175, showing the two stigmal plates; A, the carina bearing left, dorsal, slit-like spiracle; B, right circular plate; C, one of the inter-spiracular nodules.

6 Dorsal view of larva x 10; A, left longitudinal tracheal trunk; B, antenna; C, termination of the right tracheal trunk in the anterior spiracle; D, posterior respiratory organ.

7 Dorsal view of puparium x 10; A, right pupal respiratory cornua with trachea leading from it; B, posterior larval respiratory organ. The outline of head, thorax with wing-pads, and abdomen of the developing fly show thru the puparium.

8 Side view of pupal respiratory cornua, highly magnified.

9 End view of pupal respiratory cornua with afferent trachea, highly magnified.

10 Side view of head of adult ♀.

11 Wing.

12 Abdomen of ♀.

13 Posterior part of thorax and abdomen of ♂.

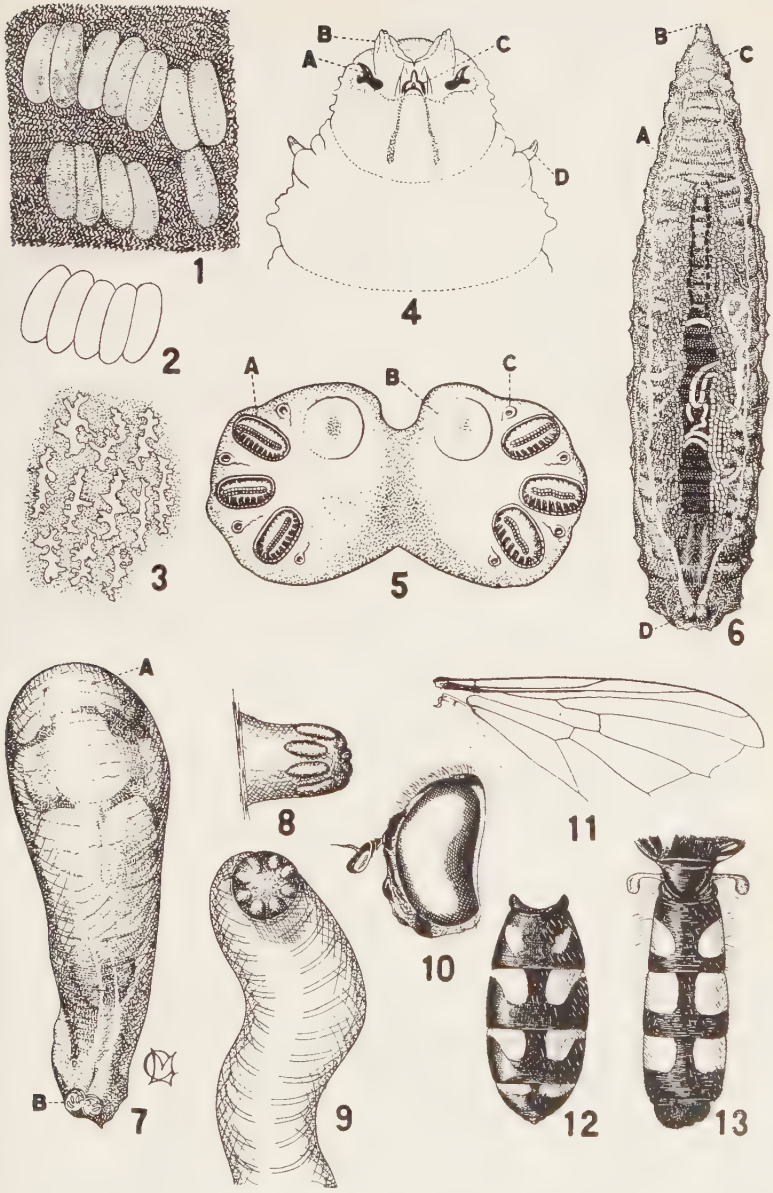

Fig. 30. Life stages of *Melanostoma mellinum* Linné.

EXPLANATION OF FIGURE 31.

61-70 *Allograpta obliqua* Say.

61 Egg x 20, from the side.

62 Dorsal view of egg x 20.

63 The sculpturing of the egg-shell, highly magnified.

64 Adult female x 7.

65 Young larva just hatched, x 50; a, antennæ; b, internal esophageal frame-work; c, the posterior respiratory tubes.

66 Mature larva x 9; a, antennæ; b, position of anterior spiracles; c, posterior respiratory tubes.

67 Antero-ventral view of head of larva much enlarged; a, antenna; b, upper jaw; c, outer pair of mouth-hooks; d, lateral mouth-hooklets; e, internal esophageal framework; f, lower jaw.

68 End view of posterior respiratory appendage, much enlarged; a, one of the spiracles; b, the circular plate; c, the interspiracular spines.

69 Dorsal view of puparium x 5; a, posterior respiratory appendage.

70 Lateral view of puparium x 3; a, posterior respiratory appendage.

71-78 *Sphaerophoria cylindrica* Say.

71 Adult male from the side x 7.

72 Dorsal view of posterior respiratory appendage, much enlarged; a, spiracles; b, circular plate.

73 End view of posterior respiratory appendage, much enlarged; a, circular plate; b, one of the three pairs of spiracles.

74 Anterior larval respiratory cornua with spiracles from the side, highly magnified.

75 End view of the same.

76 Mature larva from the side x 6; a, posterior respiratory appendage.

77 Ventral view of head of larva much enlarged; a, antennæ; b, upper jaw; c, lateral mouth-hooklets; d, the outer pair of mouth-hooks; e, esophageal framework; f, lower jaw.

78 Lateral view of puparium x 7; a, the posterior respiratory appendage; the dotted lines represent other shapes in which the pupal envelope may indurate.

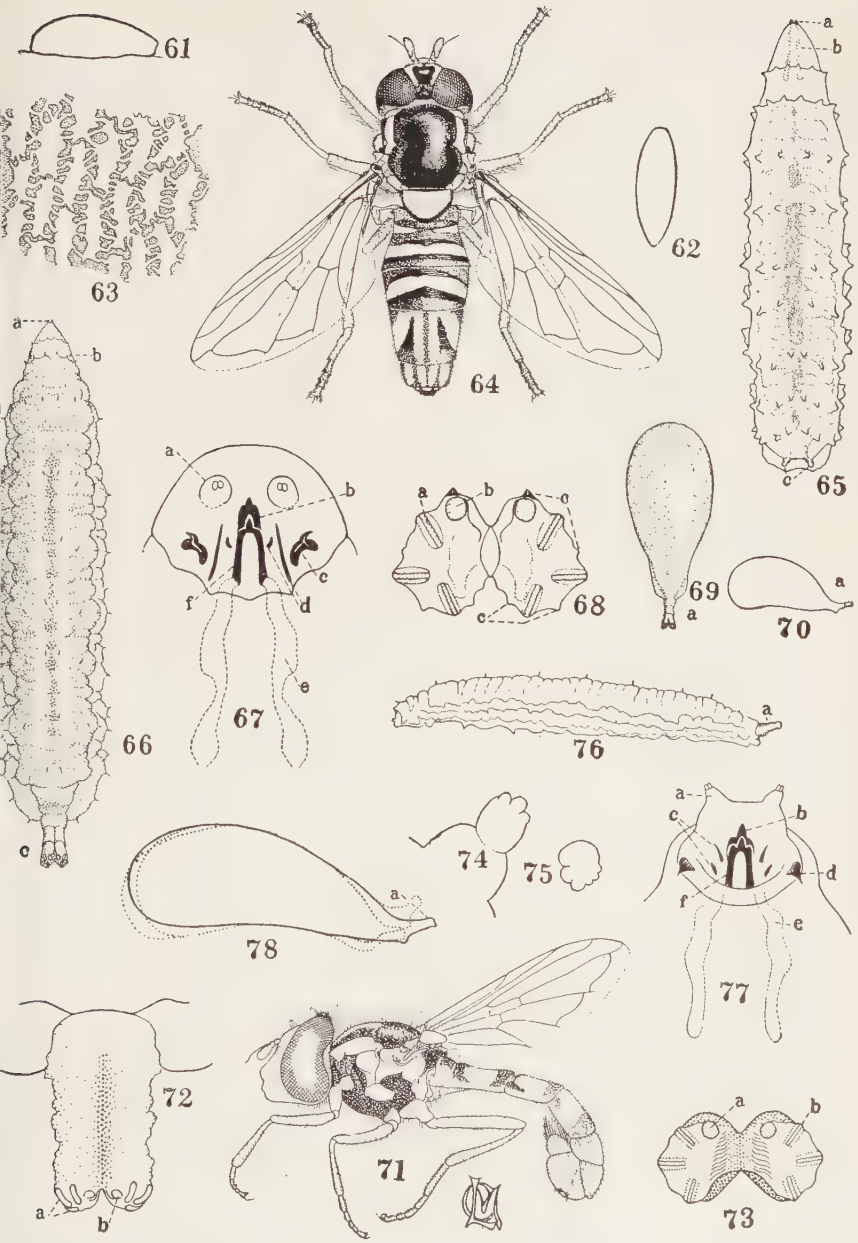

Fig. 31. Life-stages of *Allograpta obliqua* and *Sphaerophoria cylindrica* (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 32.

Syrphus americanus Wied.

41 Egg from the side x 17.
42 Dorsal view of egg x 17.
43 A small part of the surface of egg-shell showing sculpturing, highly magnified.
44 Adult male about 5 times natural size.
45 Larva just hatched x 59; a, posterior respiratory appendage.
46 Full-grown larva x 7; a, antennæ; b, anterior spiracle; c, posterior respiratory appendage.
47 Anterior view of larva, much enlarged, showing mouth-parts, antennæ, etc.; a, right anterior spiracle; b, antenna; c, upper jaw; d, lower jaw; e, the three pairs of mouth-hooks.
48 Dorsal view of right anterior spiracle, highly magnified.
49 End or posterior view of posterior respiratory organ x 55; a, dorsal spiracular spine; b, one of the three pairs of slit-like spiracles.
50 Side or dorsal view of posterior respiratory organ x 55; lettering as in Fig. 49.
51 Appearance of a part of the puparium externally in the region of the mouth-parts much enlarged; a, right anterior spiracle with short piece of trachea attached; b, lower jaw of larva; c, upper jaw of larva; d, chitinous esophageal framework; e, mouth-hooks of larva.
52 Hind leg of pupa showing flexure of tibiæ at a.
53 An early pupal stage from the side; a, b, and c, developing legs; d, wing-pad; e, mouth-parts.
54 A much later pupal stage, ventral view; a, the delicate investing membrane.
55 Dorsal view of puparium x 5; a, posterior respiratory organ.
56 Outline of puparium from the side. The dotted outline is given to show the typical shape of a parasitized puparium.
57 Lateral view of head of female x 7.
58 Larva of parasite, *Bassus lactatorius;* mouth-parts at a, ventral view.
59 Pupa of *B. lactatorius,* ventral view.

Figs. 53, 54, 58, and 59 each about 5 times natural size.

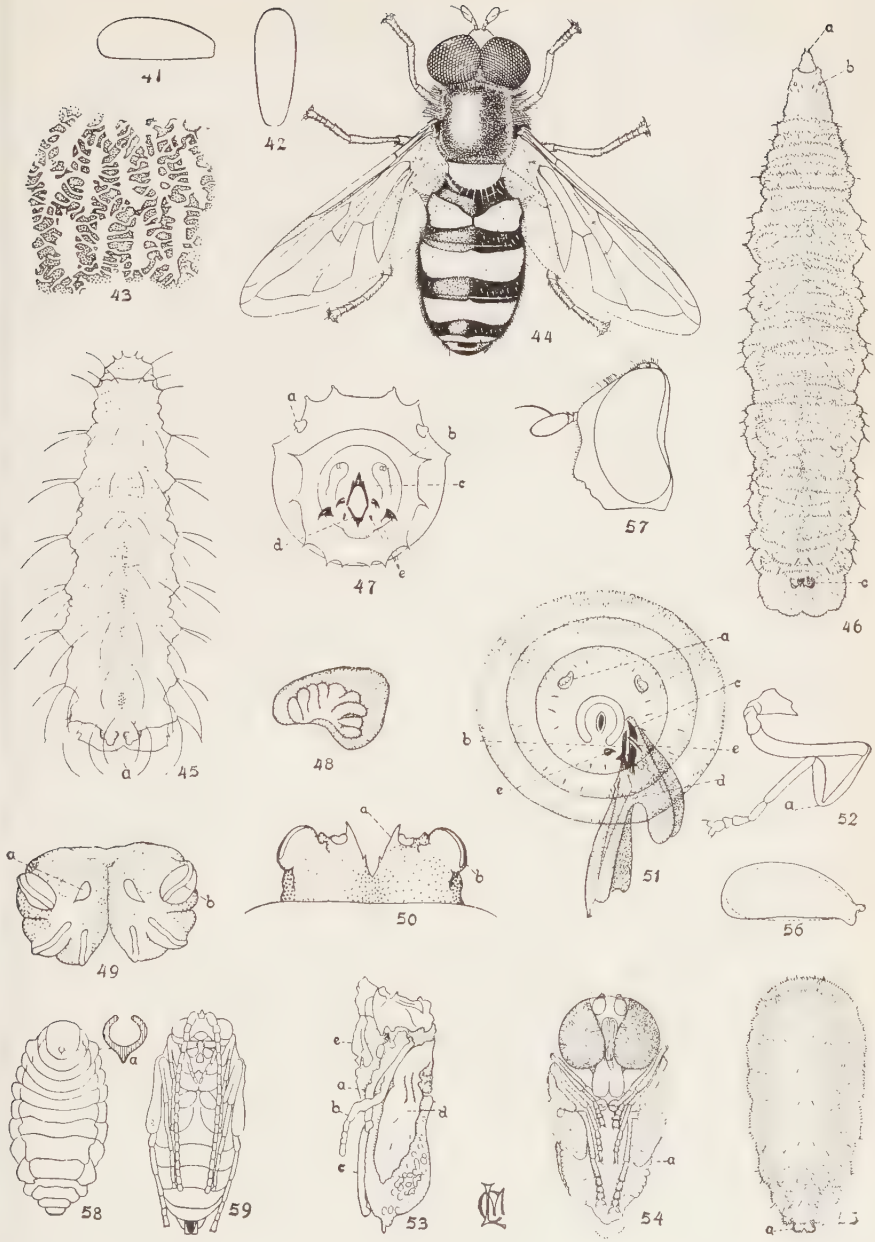

Fig. 32. Life stages of *Syrphus americanus* Wied. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 33.

Syrphus torvus Loew.

9 Adult male, natural size and enlarged.

10 Larva, natural size and enlarged; a, anterior spiracle; b, posterior spiracle.

11 Antero-ventral view of head and mouth-parts much enlarged; a and b, upper and lower jaws partially separated; c, outer pair of mouth hooks; d and e, two inner pairs of mouth-hooklets; f, antenna; g, anterior spiracle; h, sense papillæ.

12 Anterior spiracle of larva highly magnified.

13 Posterior breathing appendages much enlarged; a, one of the six caudal spiracles.

14 Puparium from above, natural size and enlarged; a, posterior spiracles.

15 Puparium from side showing line of cleavage for escape of adult.

16 Head of female in profile.

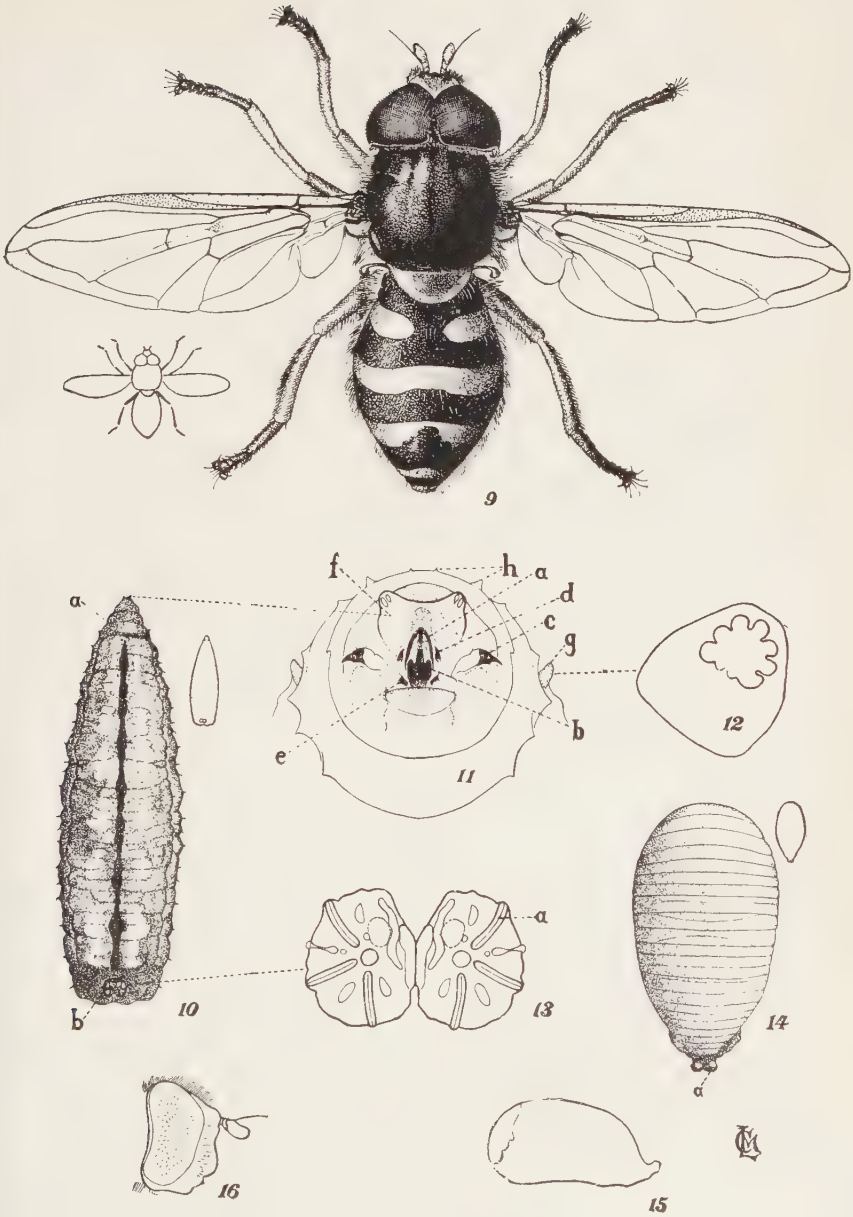

Fig. 33. Life-stages of *Syrphus torvus* Loew. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 34.

Syrphus nitens Ztt.

1 Dorsal view of larva x 7.5; A, antenna; B, posterior respiratory organ.

2 Anterior larval spiracle, highly magnified.

3 End view of posterior respiratory organ x 75, showing the two stigmal plates; A, circular plate; B, one of the inter-spiracular nodules; C, median slit-like spiracle.

4 Postero-ventral view of posterior respiratory organ x 75, showing the position of the three pairs of extensively-convoluted, slit-like spiracles; the carinæ on which they are elevated; and the ridges median to the circular plates.

5 The retractile, renal? flabellæ, as protracted from the anal opening.

6 Dorsal view of puparium x 7.5; showing shape, markings, and at A, the posterior, larval, respiratory organ.

7 Dorsal view of adult ♂, x 7.5.

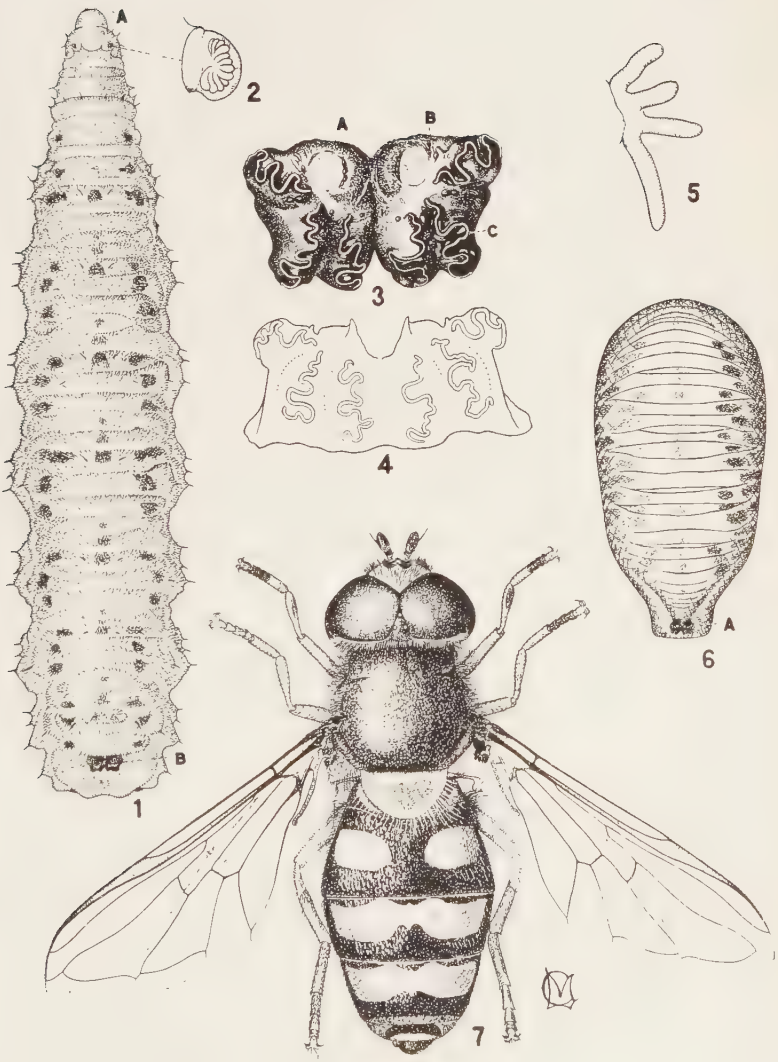

Fig. 34. Life-stages of *Syrphus nitens* Ztt..

EXPLANATION OF FIGURE 35.

Didea fasciata Macq. var *fuscipes* Loew.

1 Adult female x 6.

2 Larva about six times natural size; a, anterior spiracle; b, caudal spiracles.

3 Antero-ventral view of head and mouth-parts of larva, enlarged; a, upper jaw with a small pair of hooklets at the side; b, lower jaw; c and d, lateral hooklets; e, antenna; f, sense papillæ.

4 Right anterior spiracle much magnified.

5 Posterior breathing organs enlarged; a, one of the radiating spiracles.

6 Dorsal view of puparium a little more than five times natural size; a, caudal spiracles.

7 Puparium from the side showing arrangement of spines and line of cleavage for escape of adult.

8 Head of male in profile.

See also Figure 29-5.

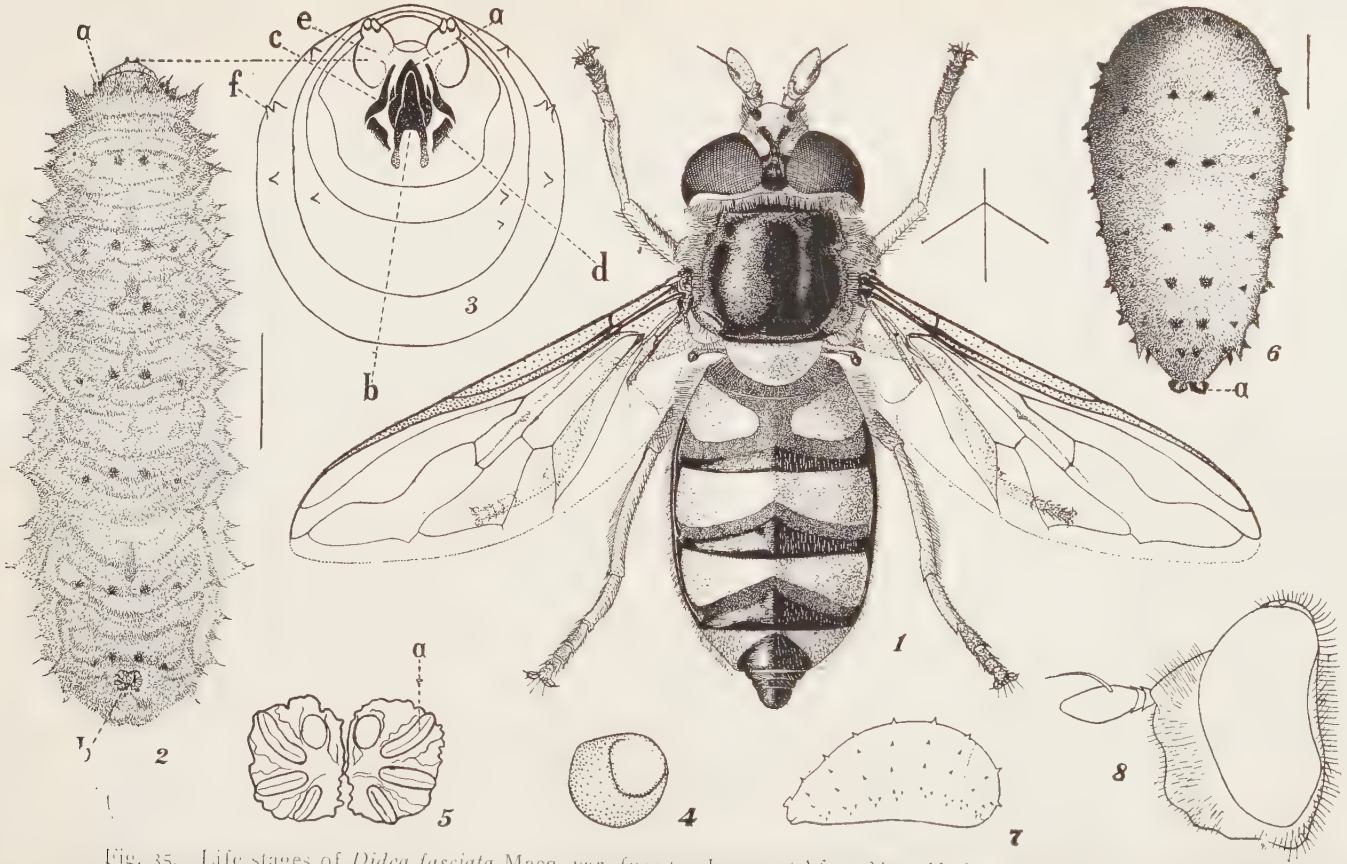

Fig. 35. Life stages of *Didea fasciata* Macq. var. *fuscipes* Loew. (After Metcalf, from The Ohio Naturalist.)

EXPLANATION OF FIGURE 36.

Tropidia quadrata Say.

1 A few areoles from one of the bodies on the surface of the egg-shell, very highly magnified.

2 A small area of the chorion or egg-shell, highly magnified, showing the elevated bodies each of which is further ornamented with a number of rounded areoles.

3 Dorsal view of an egg x 22.

4 Anterior larval spiracle highly magnified.

5 Dorsal view of larva x 6; A, antenna; B, anterior larval spiracle, just laterad of which are the two large lateral hooks; C, posterior respiratory organ, at each side of which are the three lateral fleshy processes from the body-wall.

6 End-view of posterior respiratory organ, showing the two stigmal plates; A, one of the palmately-arranged groups of plumose, interspiracular hairs; B, circular plate; C, dorsal slit-like spiracle showing characteristic shape and dentations; much magnified.

7 Anterior view of head-segments of larva, much enlarged, showing arrangement of spines or thorns; A, the posterior row of thorns; B, anterior larval spiracle, situated in the middle row of thorns; C, the two pairs of large, lateral thorns, between which is the anterior row of thorns; D, left antenna; E, the first pair of pro-legs; F, the mouth-hood.

8 Lateral view of puparium x 6; A, left pupal respiratory cornua, B, posterior larval respiratory organ, at the side of which are the three lateral processes from the body-wall. Note also in the cephalo-ventral region the thorns of the larval head.

9 A group of papillæ from the pupal respiratory cornua, very highly magnified, each showing a number of nodules arranged in a circle.

10 Anterior view of puparium x 12; A, left pupal respiratory cornua; B, anterior larval spiracle; C, remnant of the larval mouth-hood; D, the two large lateral thorns or hooks of the larval head. The heavy dotted lines enclose the two pieces of the operculum which split off for the emergence of the adult.

11 Side view of head of male, showing characteristic facial carina.

12 Dorsal view of scutellum and abdomen of male, showing characteristic markings.

13 Wing.

14 Hind leg showing angular projection at outer end of femur.

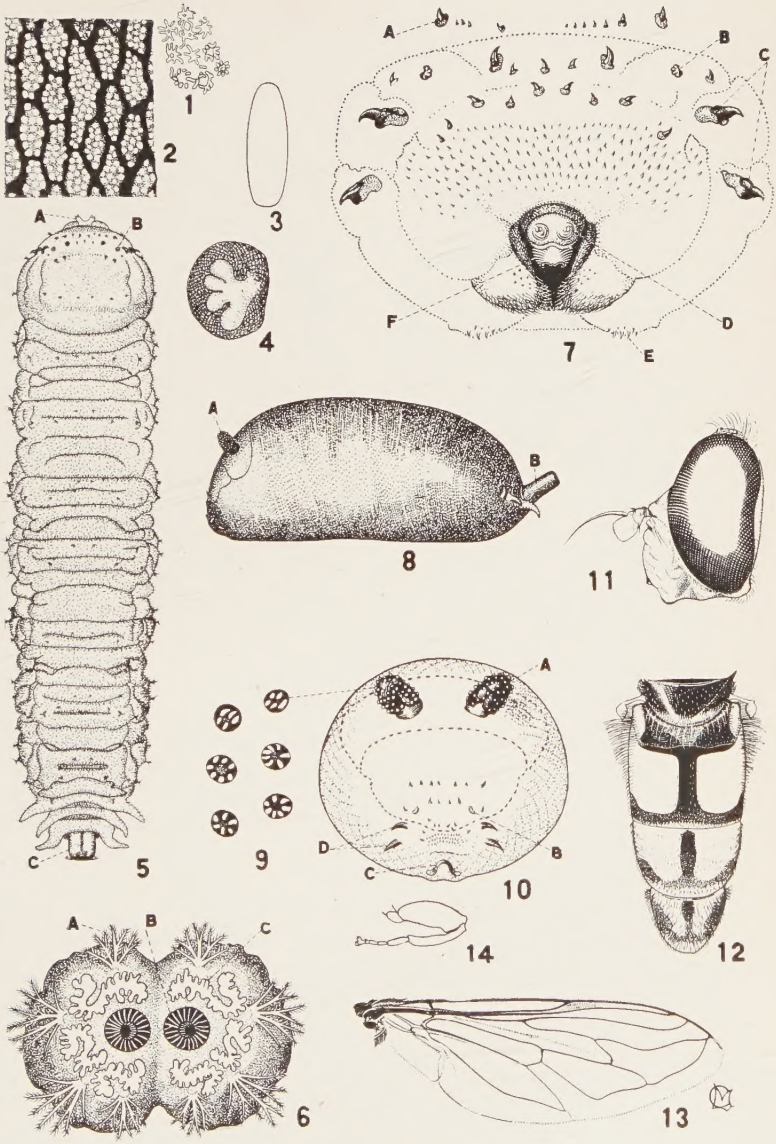

Fig. 36. Life-stages of *Tropidia quadrata* Say.

EXPLANATION OF FIGURE 37.

Syritta pipiens Linné.

1 A mass of eggs as deposited by a female on filth x 20.

2 A few areoles from one of the bodies on the surface of the egg-shell, very highly magnified.

3 A small area of the chorion or egg-shell highly magnified, showing the elevated bodies each of which is further indistinctly marked with rounded areoles.

4 Anterior larval spiracle, highly magnified.

5 Larva, dorsal view x 6; A, antenna; B, posterior respiratory organ.

6 Dorsal view of puparium x 6; A, pupal respiratory cornua; B, posterior larval respiratory organ.

7 A group of papillæ from the pupal respiratory cornua each composed of four to six nodules circularly arranged; very highly magnified.

8 One of the pupal respiratory cornua much enlarged.

9 End view of posterior respiratory organ, showing the two stigmal plates each with a circular plate, three slit-like, sinuate and denticulated spiracles (A), and four groups of palmately-arranged, plumose, inter-spiracular hairs.

10 Wing.

11 Hind leg, showing color-pattern and spines on femur.

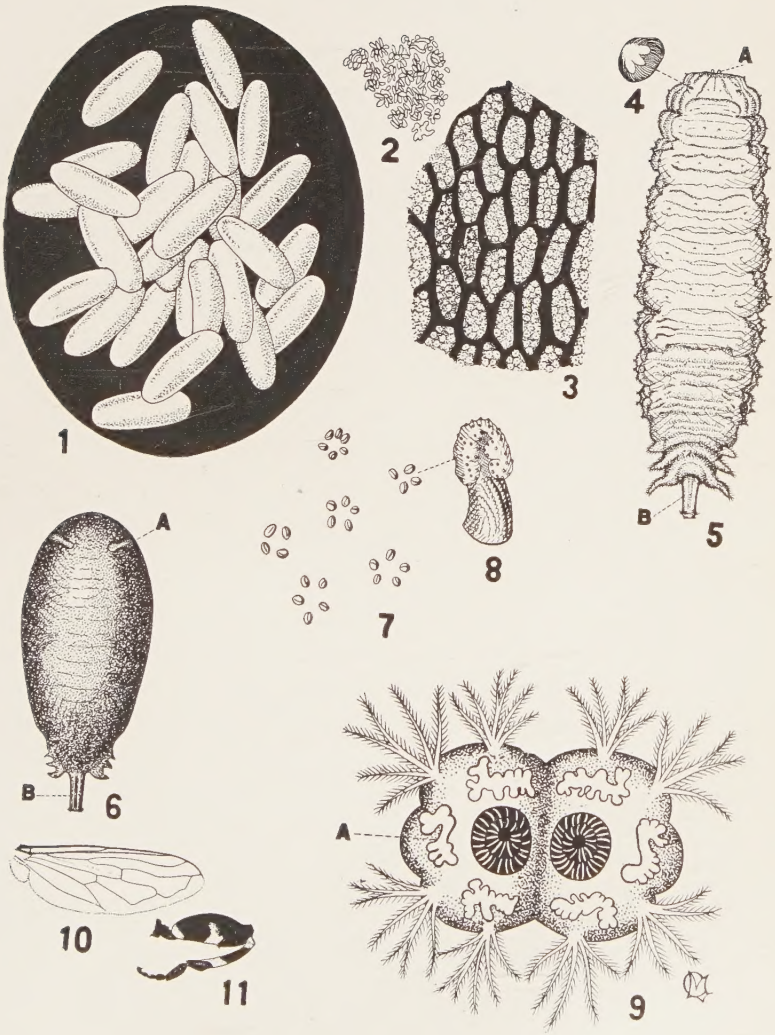

Fig. 37. Life-stages of *Syritta pipiens* Linné.

I. B.
E.